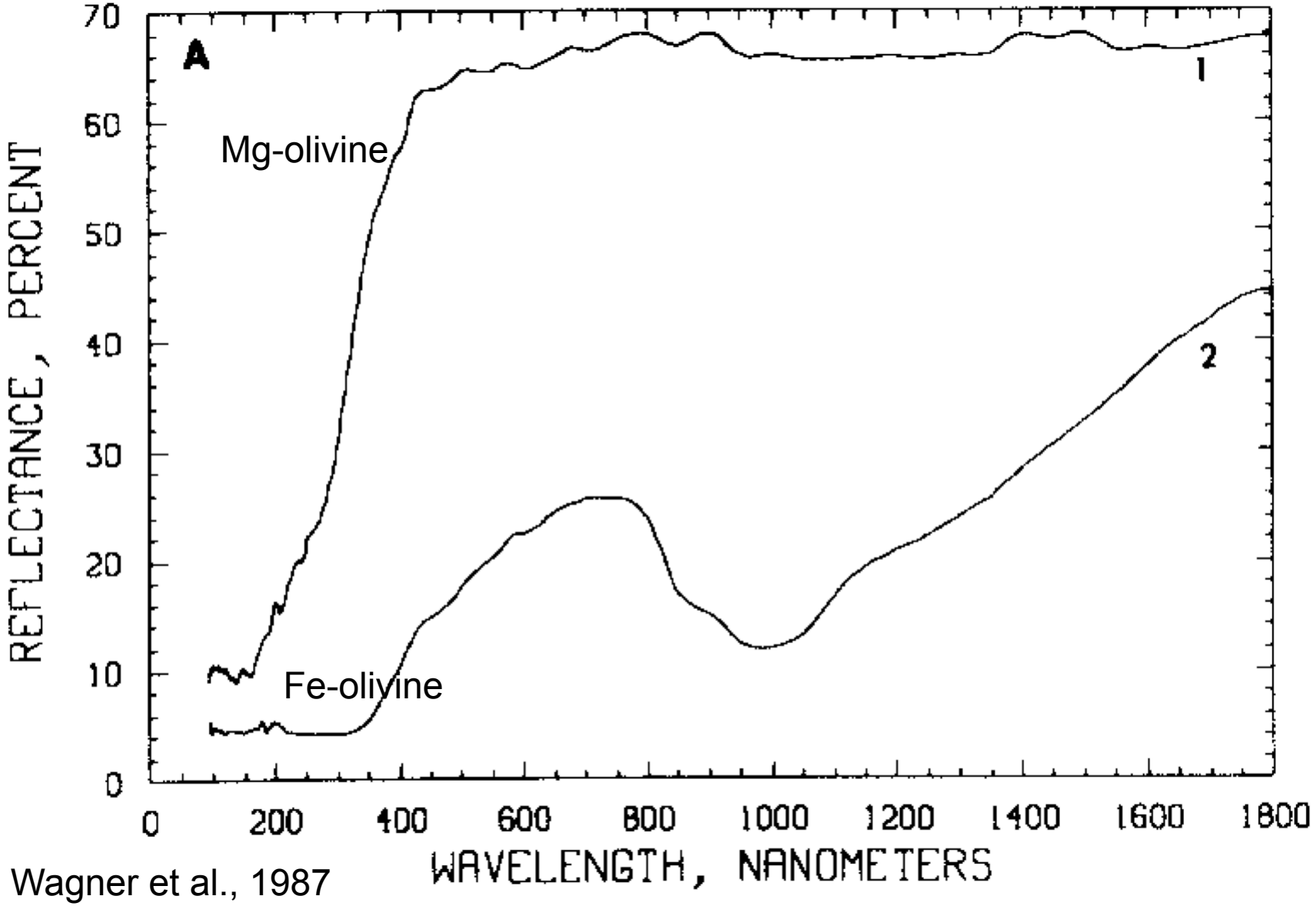
Characterizing "WATER" on airless bodies from vacuum UV and IR measurements

Karl Hibbitts, *JHU-APL;*
karl.hibbitts@jhuapl.edu

VORTICES
VOlatile Regolith Thermal Investigations Consortium for Exploration & Science

APL
JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

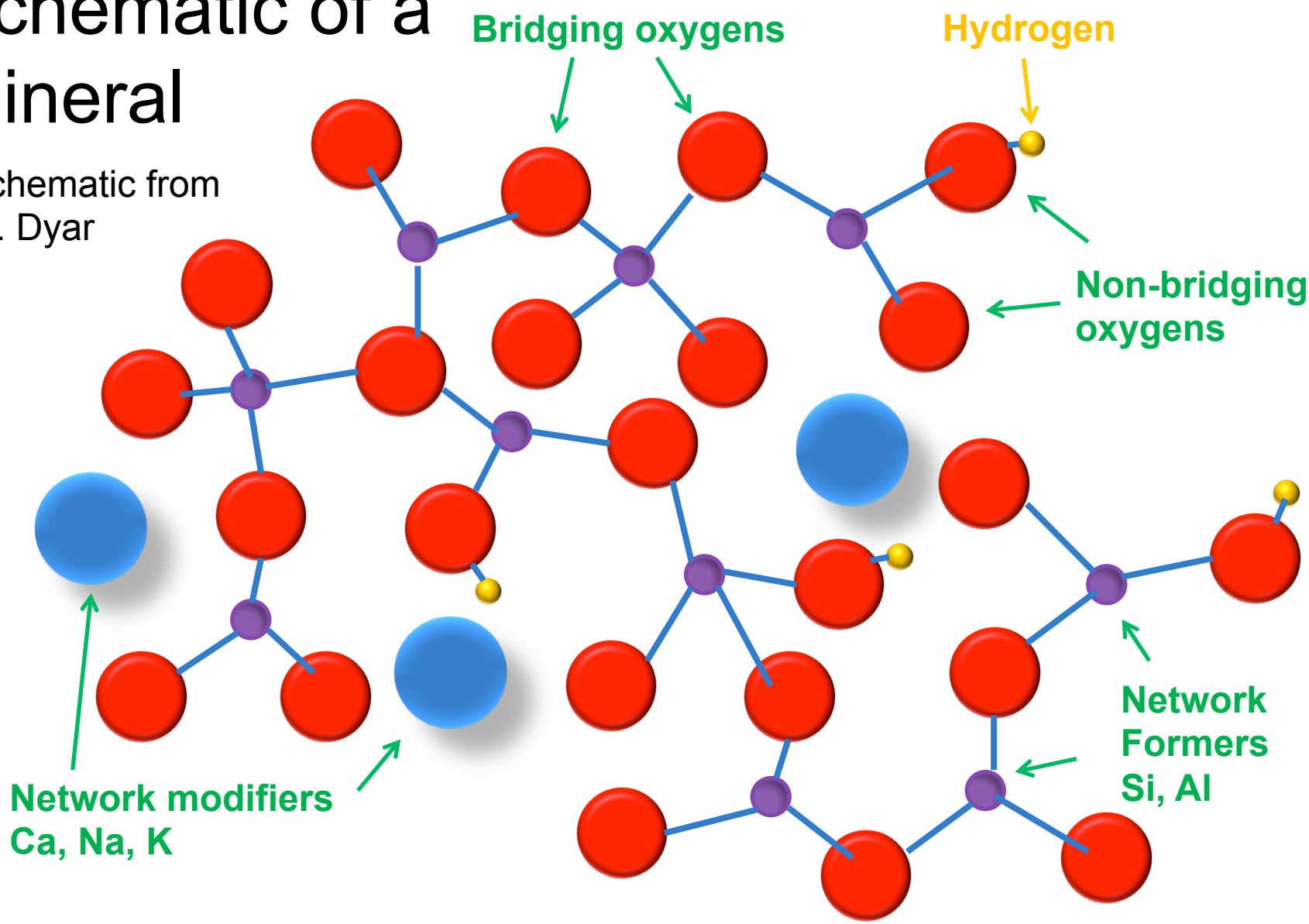
Using the UV for composition…Not a new idea..



Wagner et al., 1987

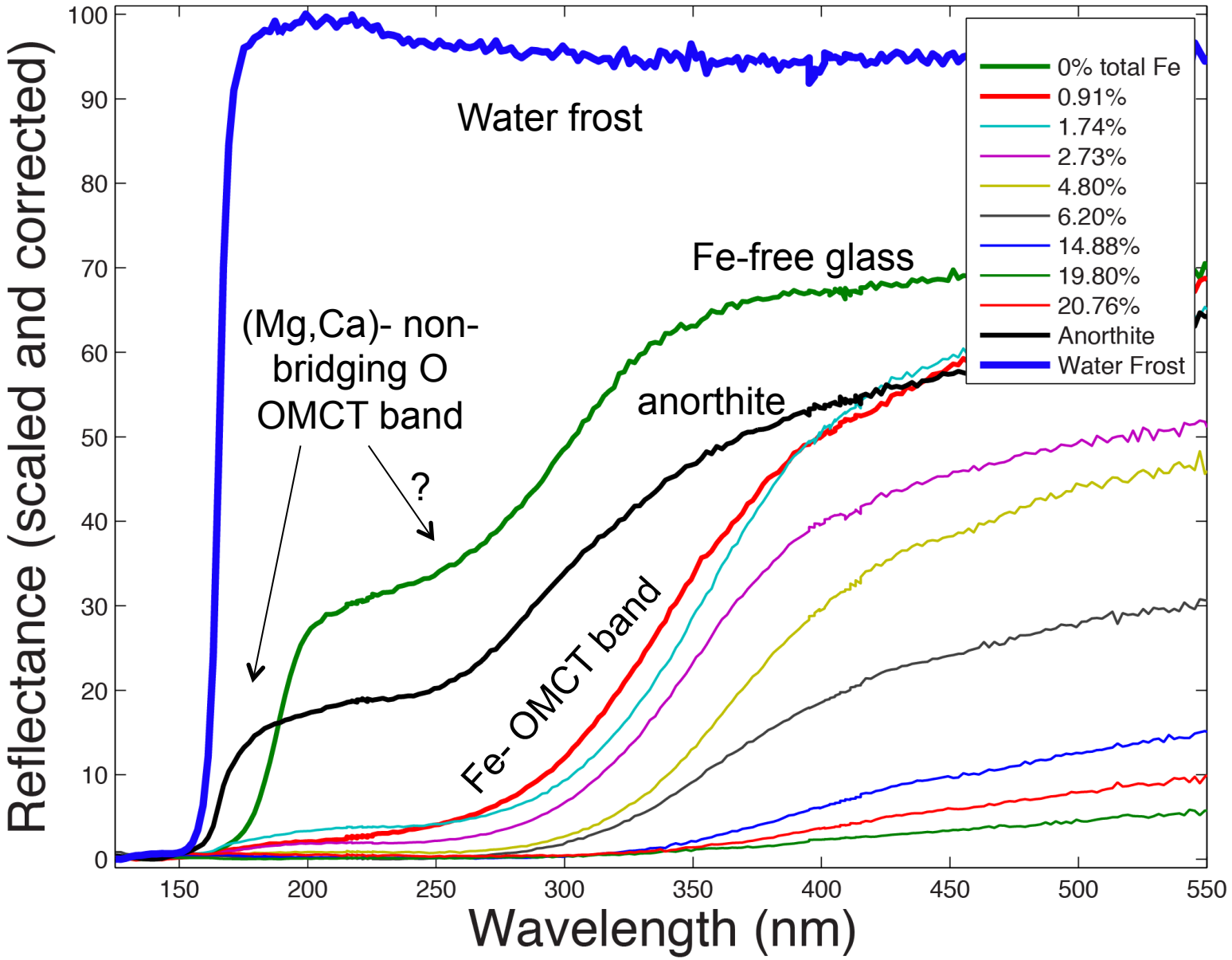
Schematic of a mineral

schematic from
D. Dyar

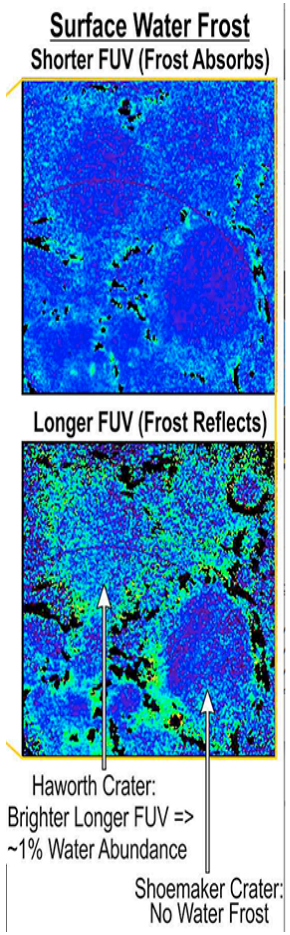


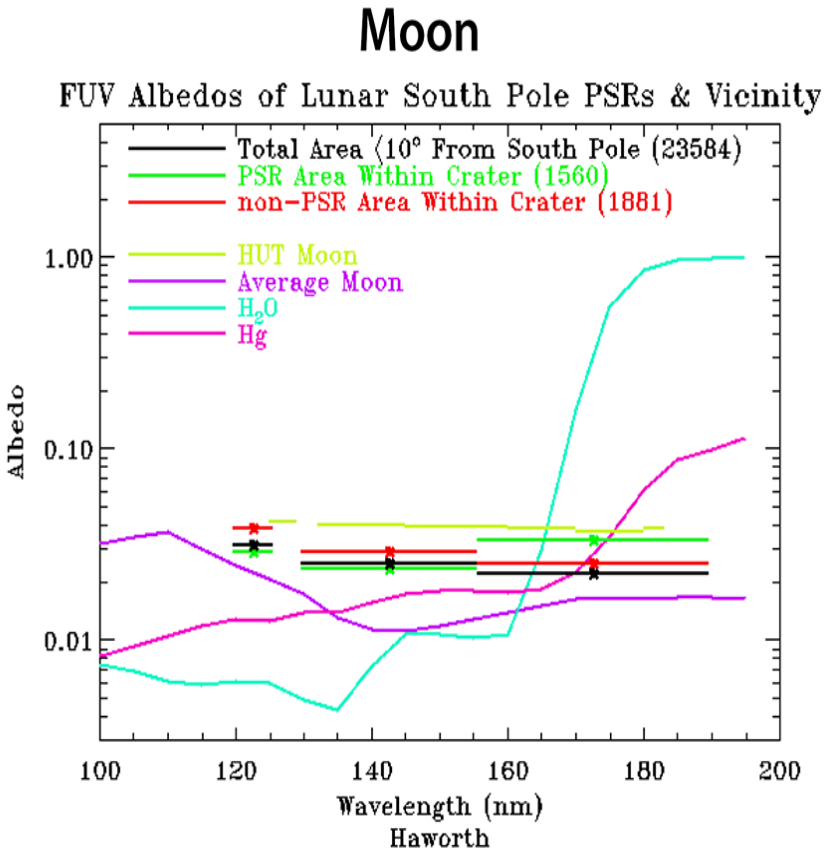
High alkali contents create non-bridge bonded oxygen for cation – oxygen charge transfer absorptions near 160 – 200 nm.

UV Reflectance of Silicates & Water Frost

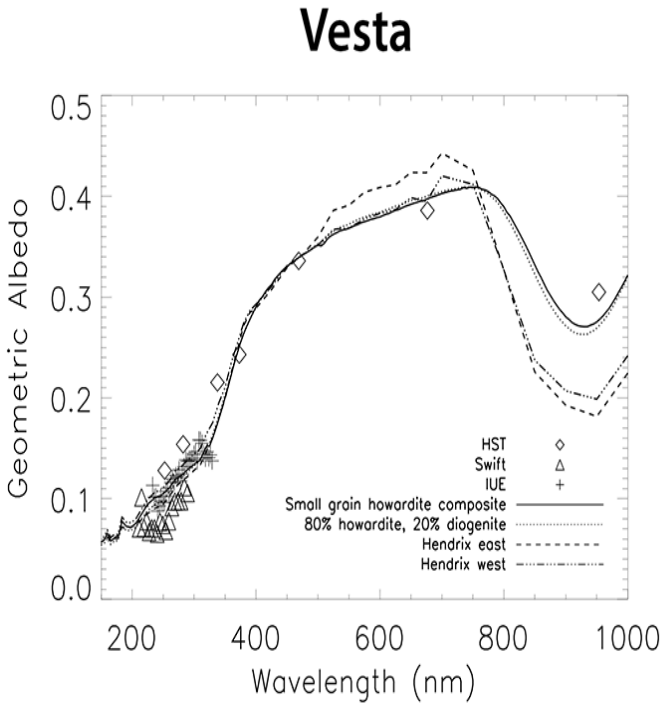


Motivation for UV measurements…





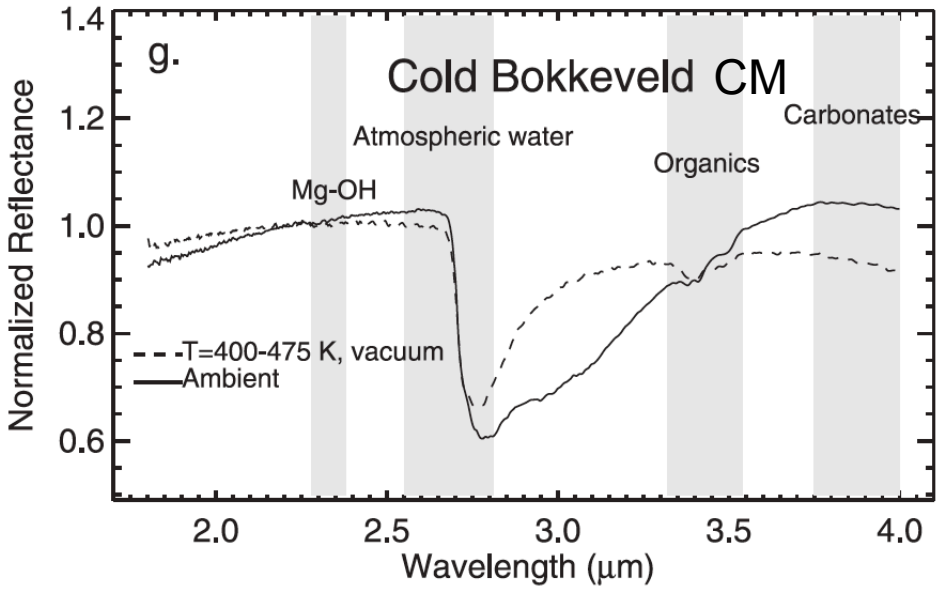
Gladstone et al., 2012)

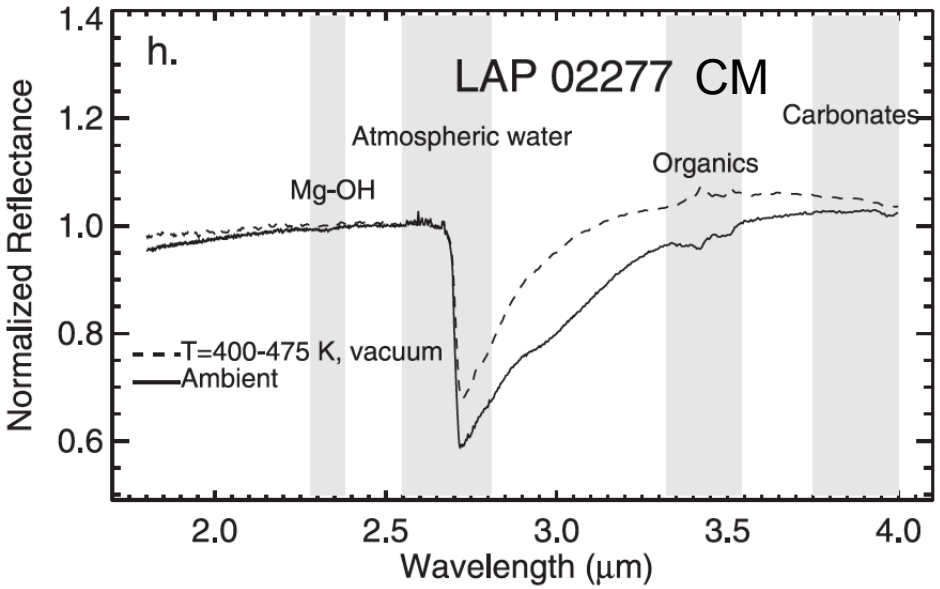


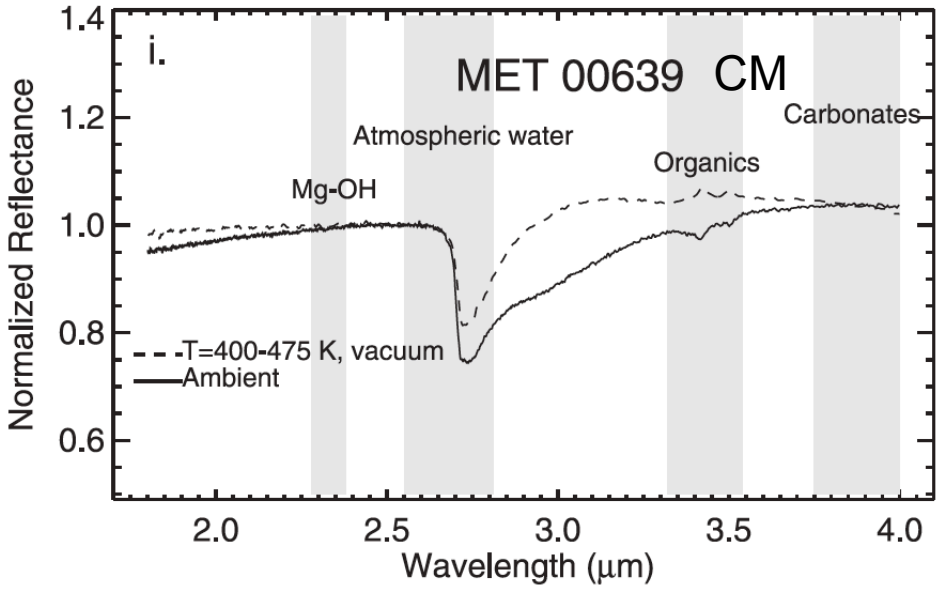
Hendrix et al., 2003

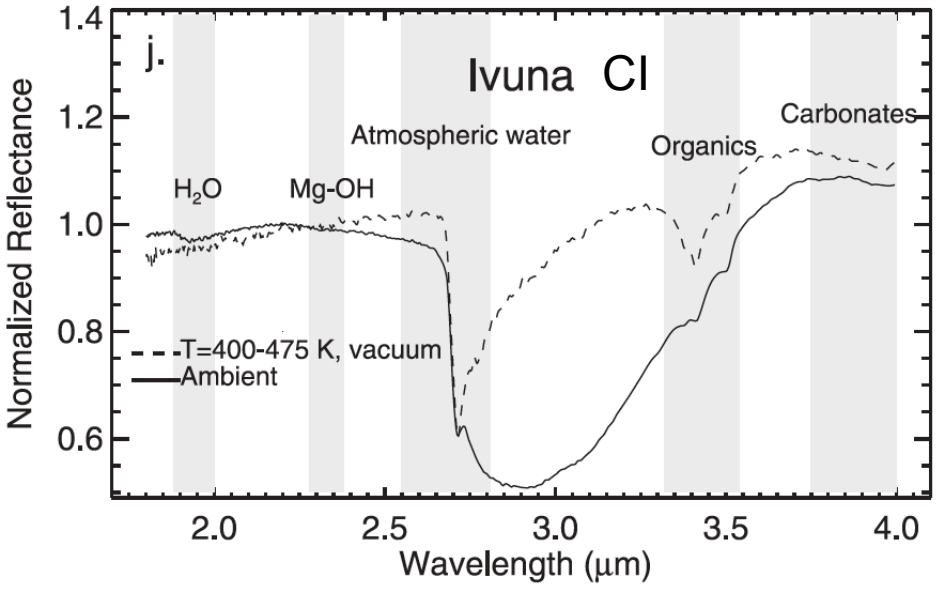
Motivation for IR measurements…

From Takir et al, 2013

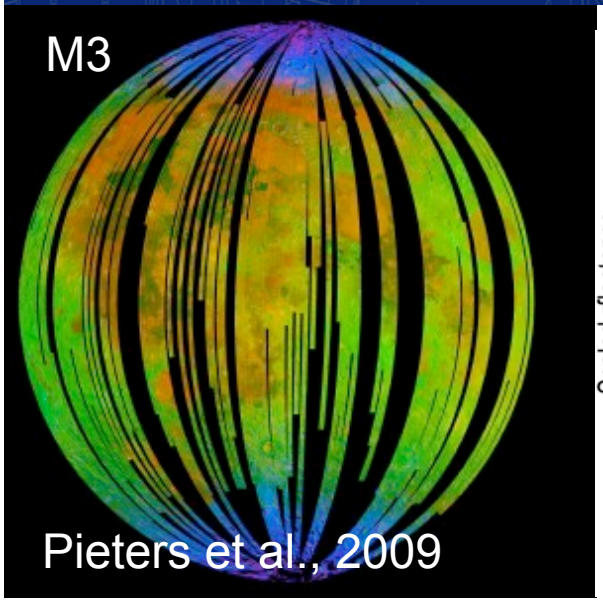


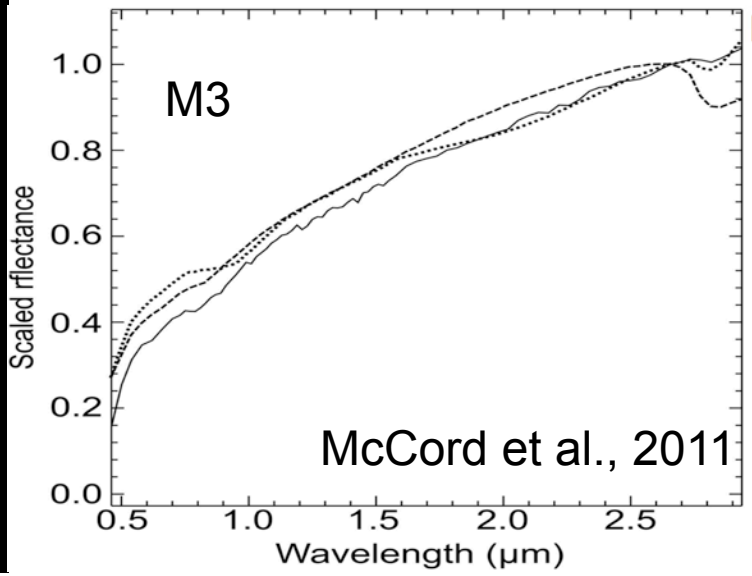


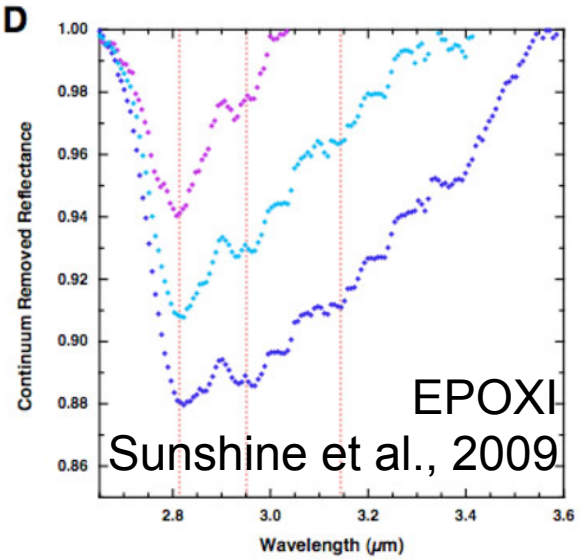


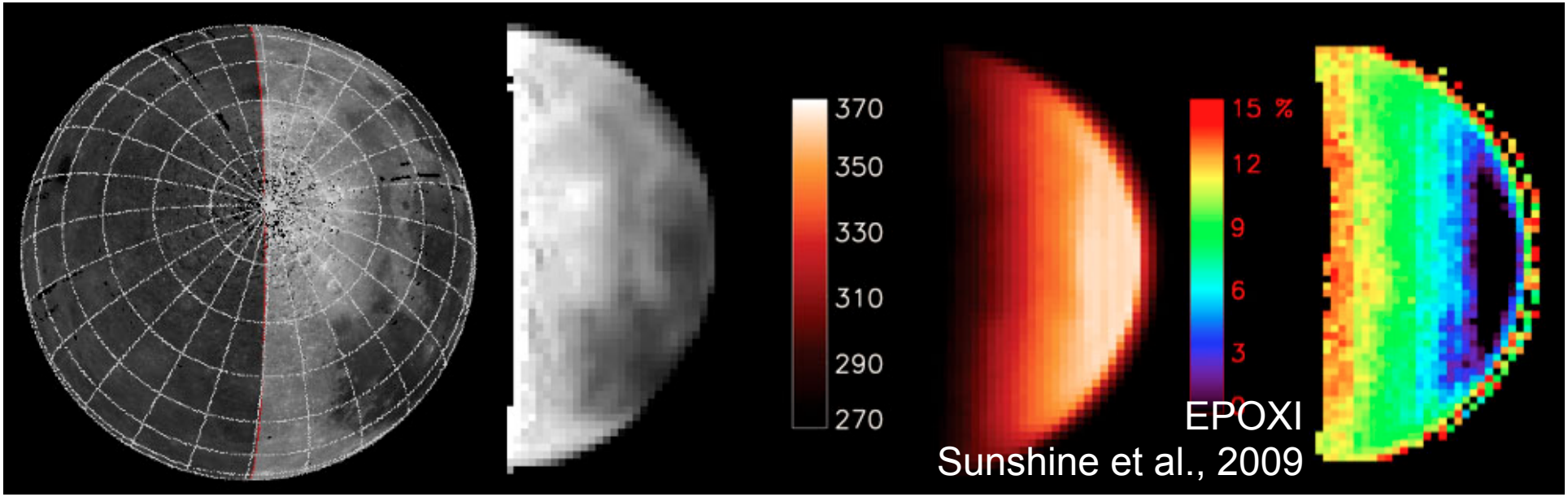


Motivation for IR measurements…Lunar

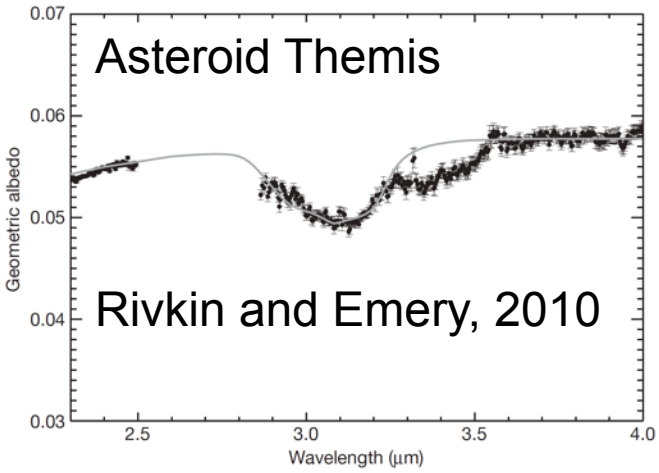


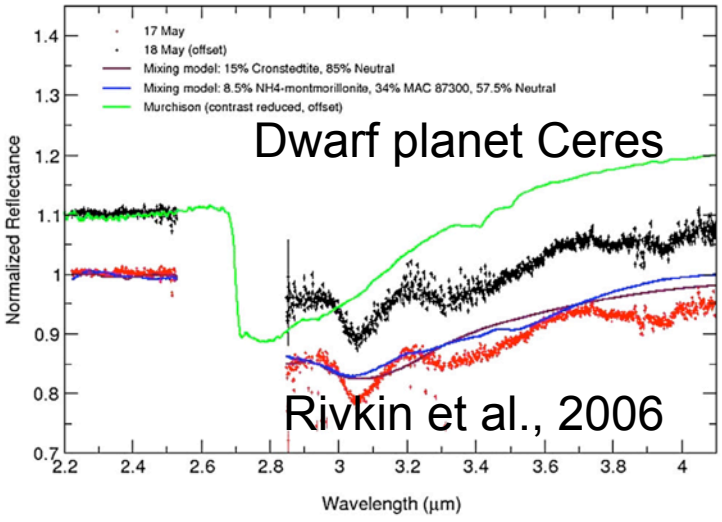


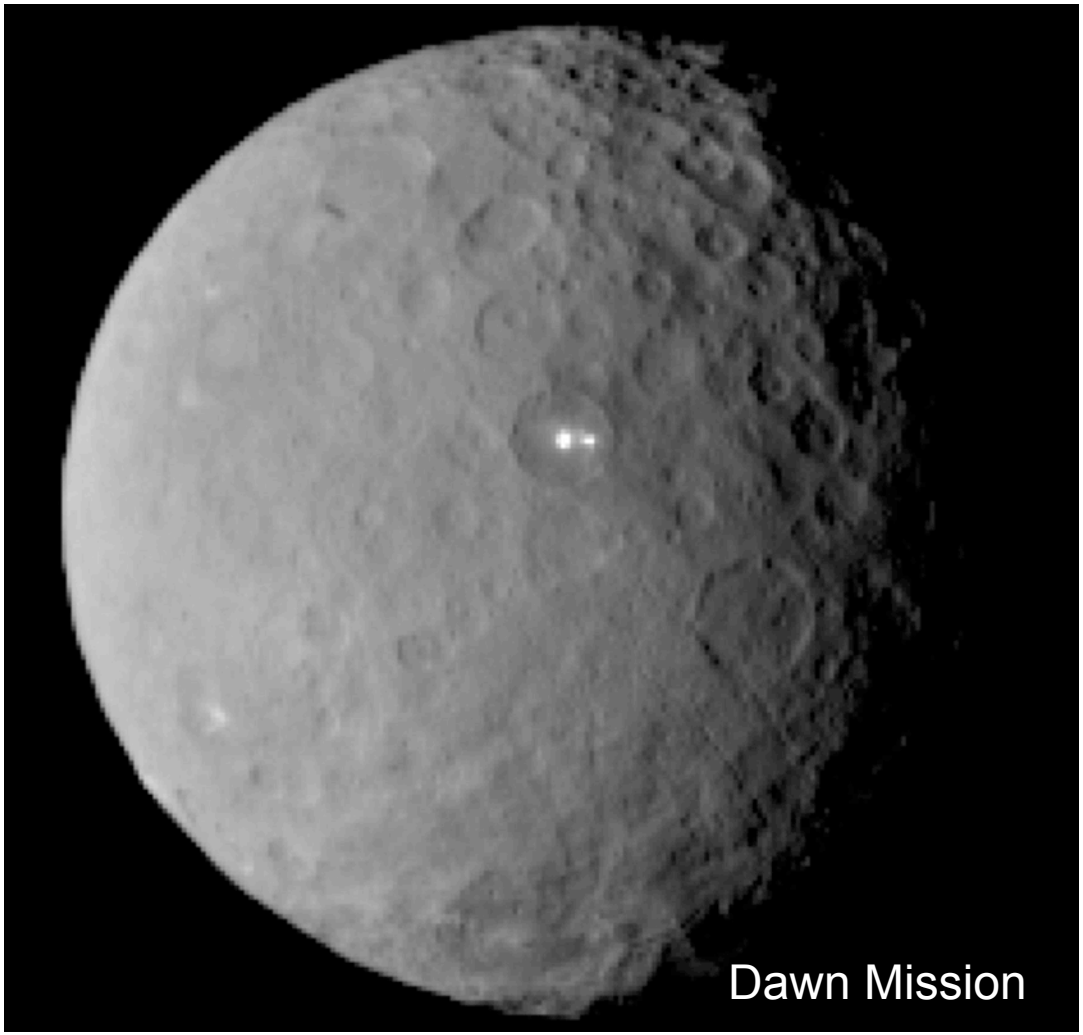




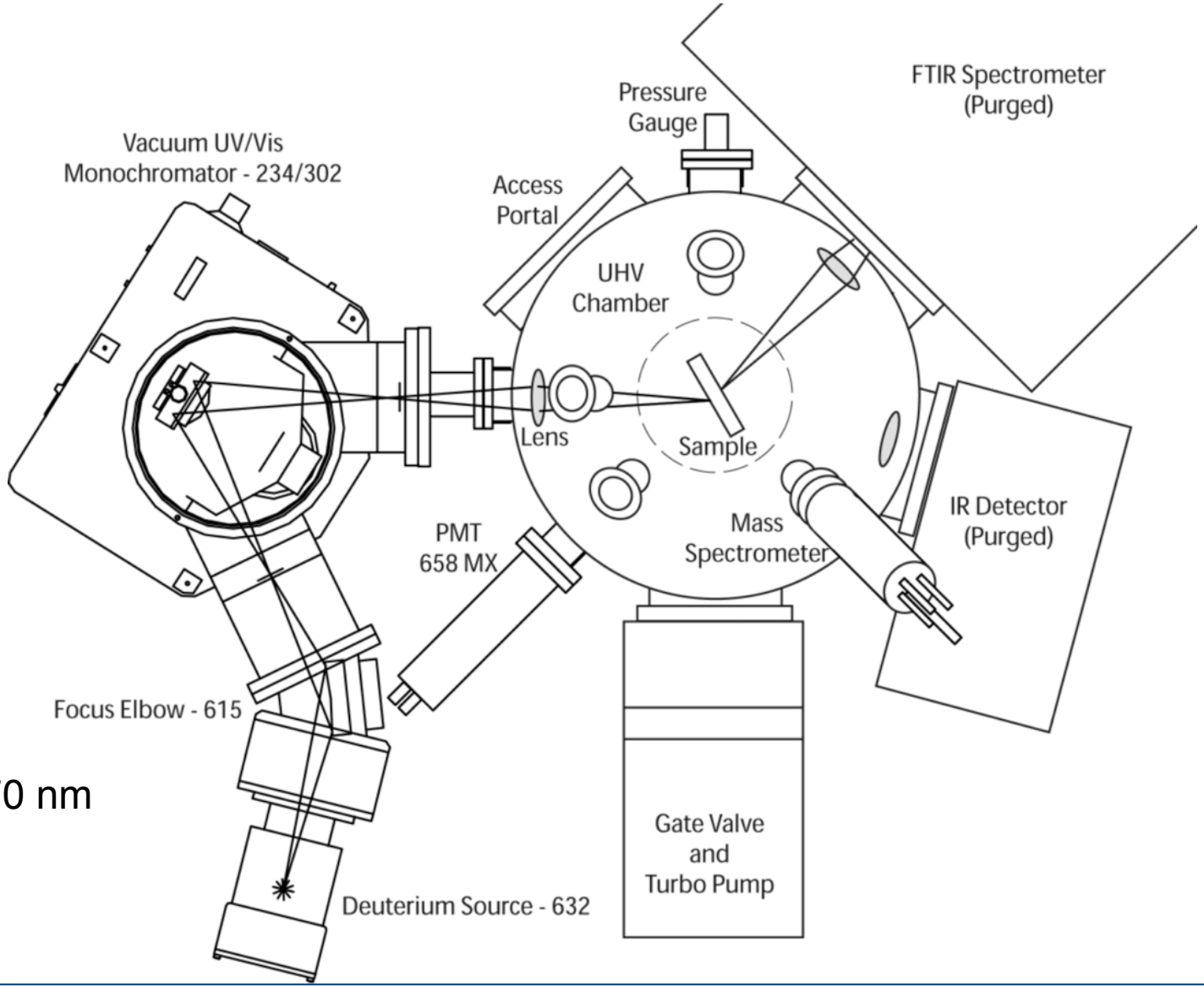
Motivation for IR measurements…Asteroid





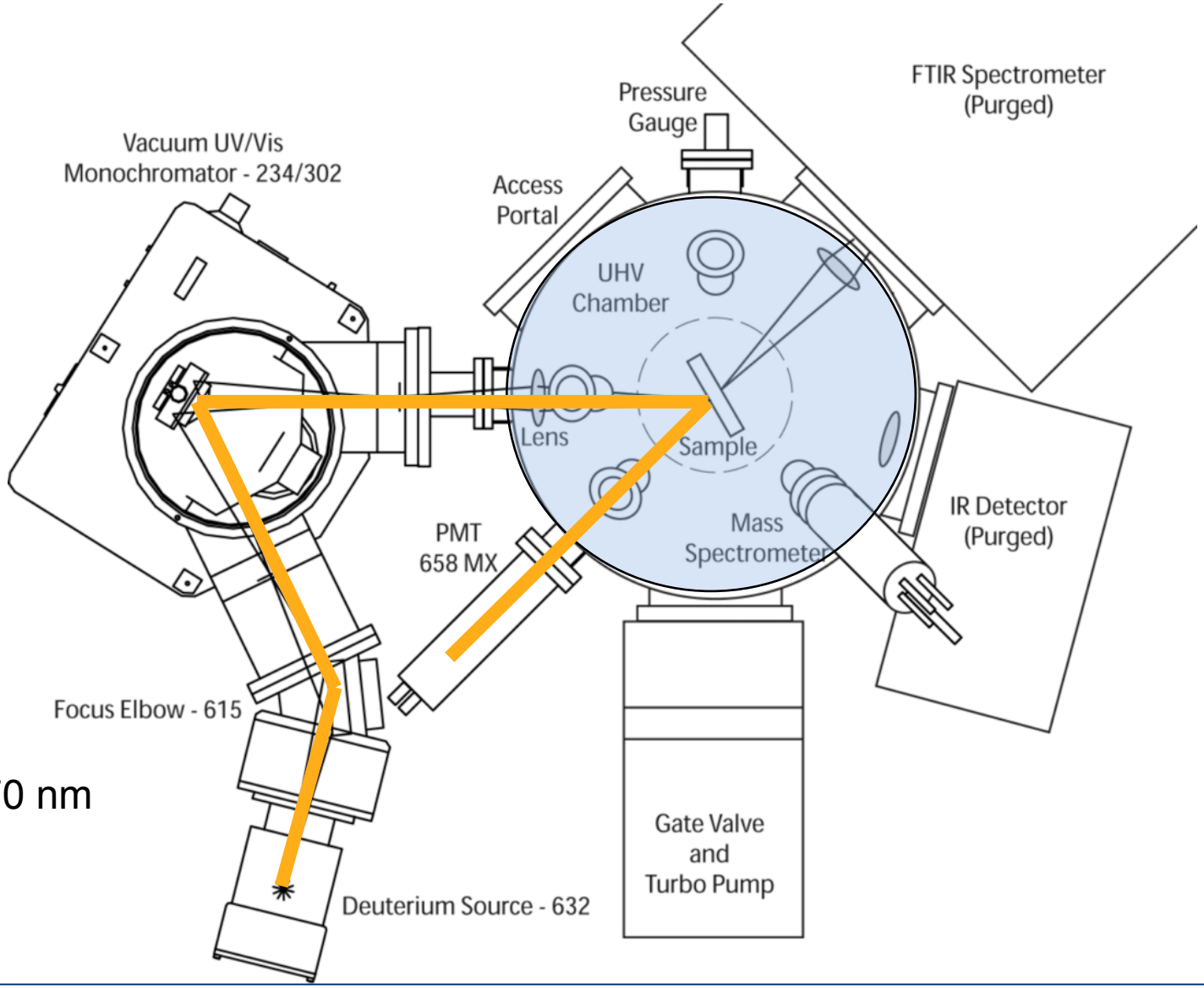


UV Experiments at APL



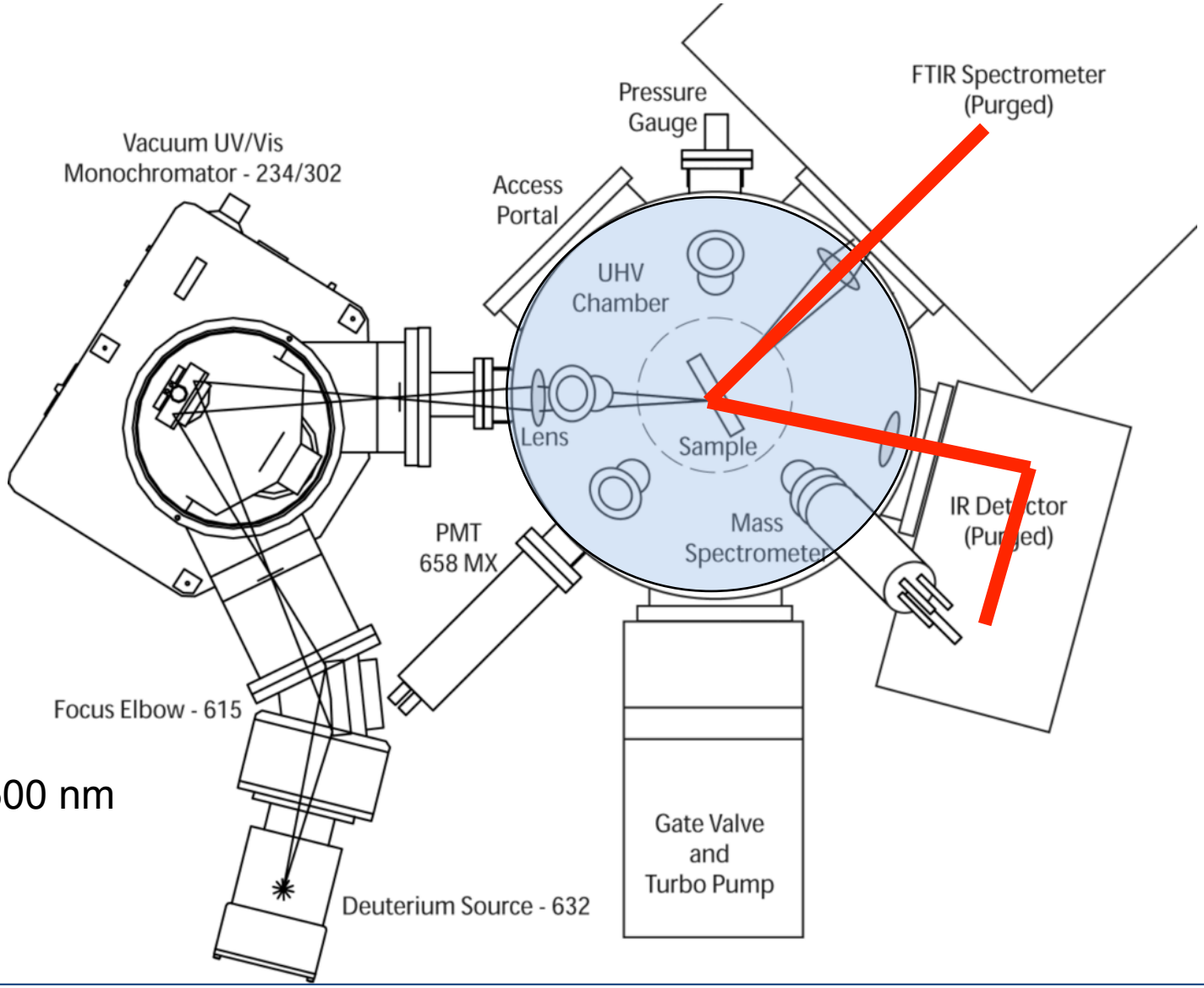
150 – 570 nm
$\alpha = 45^{o}$
$i = 5^{o}$
$e = 40^{o}$

UV Experiments at APL



150 – 570 nm
$\alpha = 45^{o}$
$i = 5^{o}$
$e = 40^{o}$

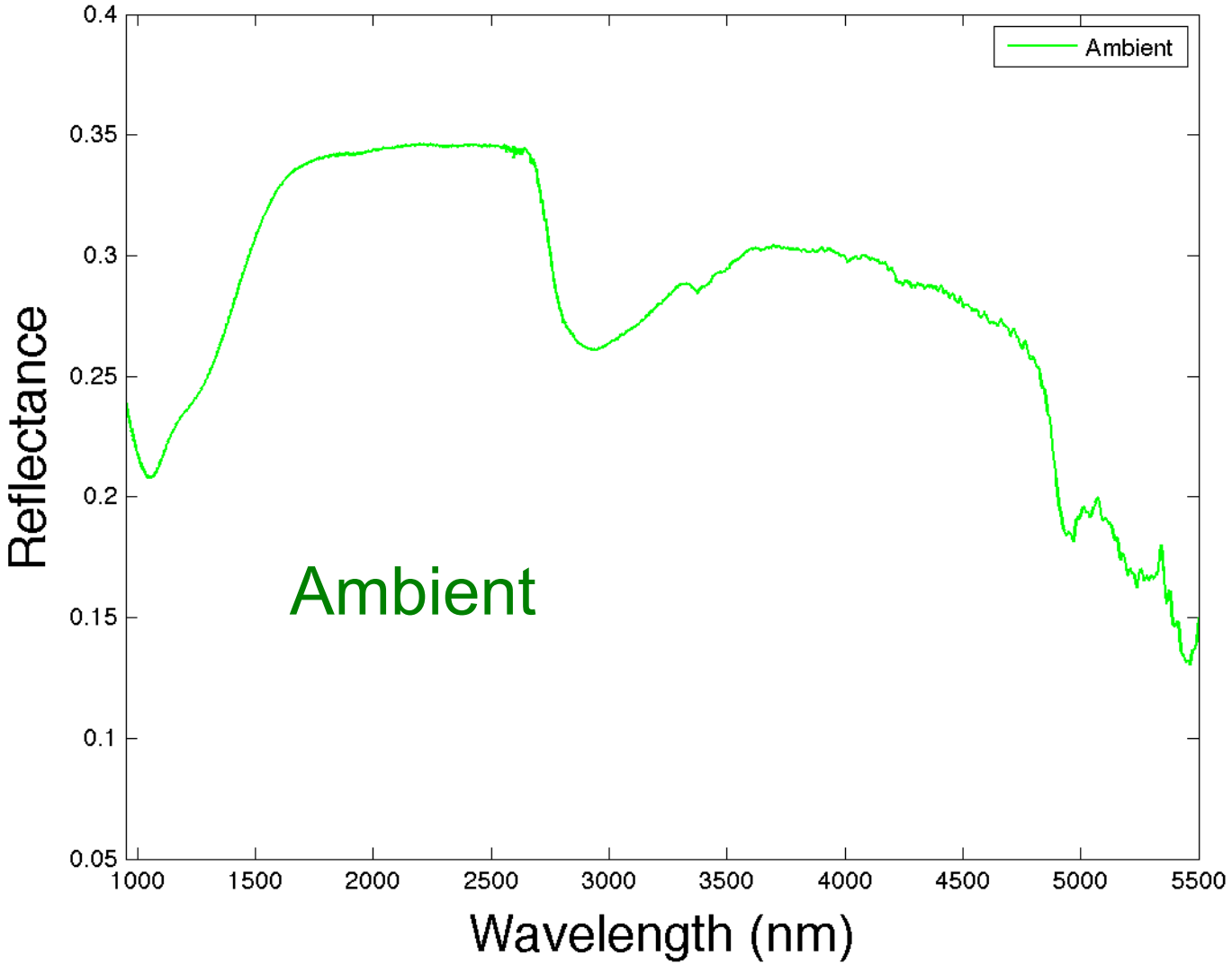
IR Experiments at APL



950 – 5500 nm
$\alpha = 45^{o}$
$i = 10^{o}$
$e = 35^{o}$

IR Water Band – San Carlos Olivine

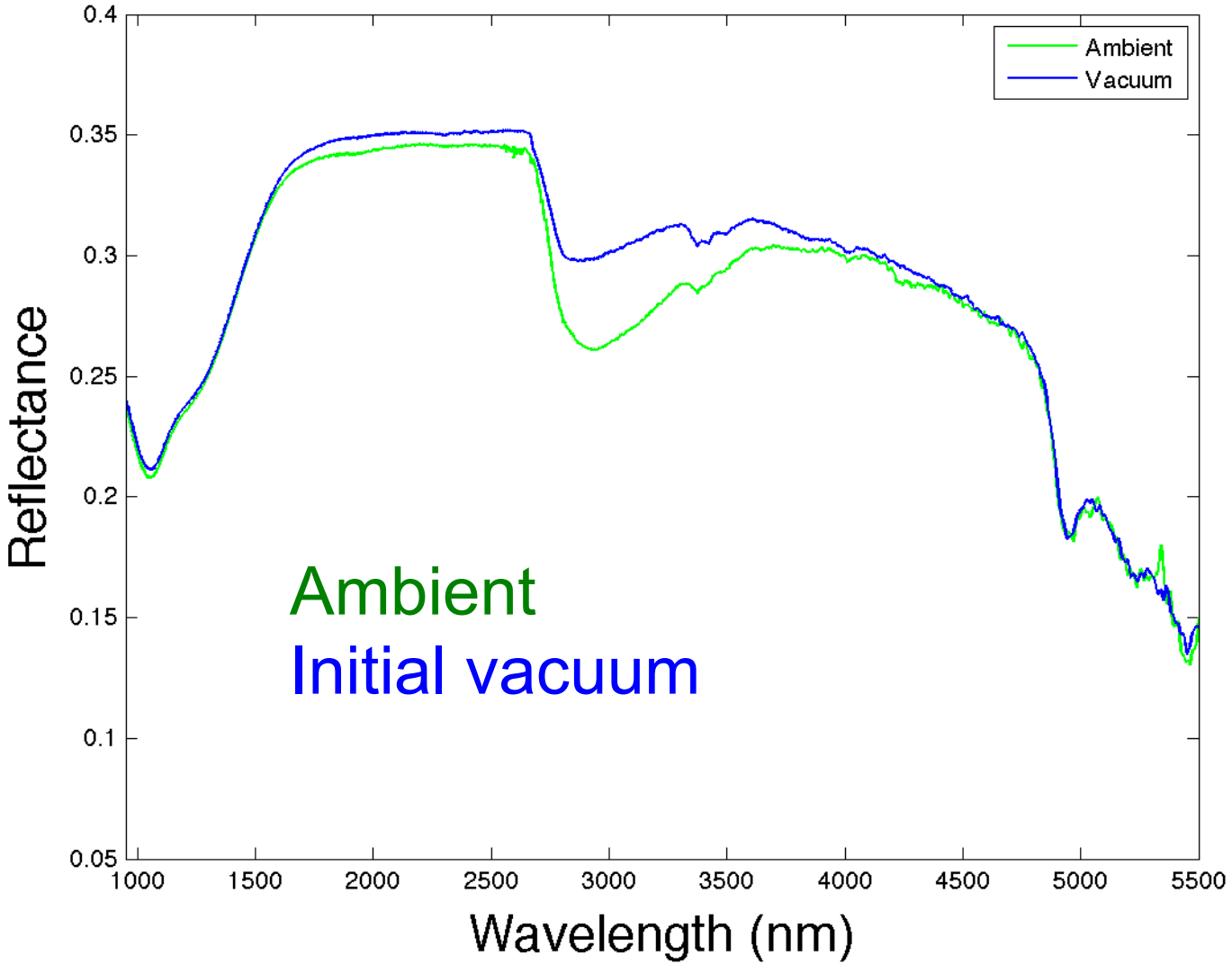
Desiccation affects the 3-micron region. Band depth and position change.



Combination of internal and adsorbed "water"

IR Water Band – San Carlos Olivine

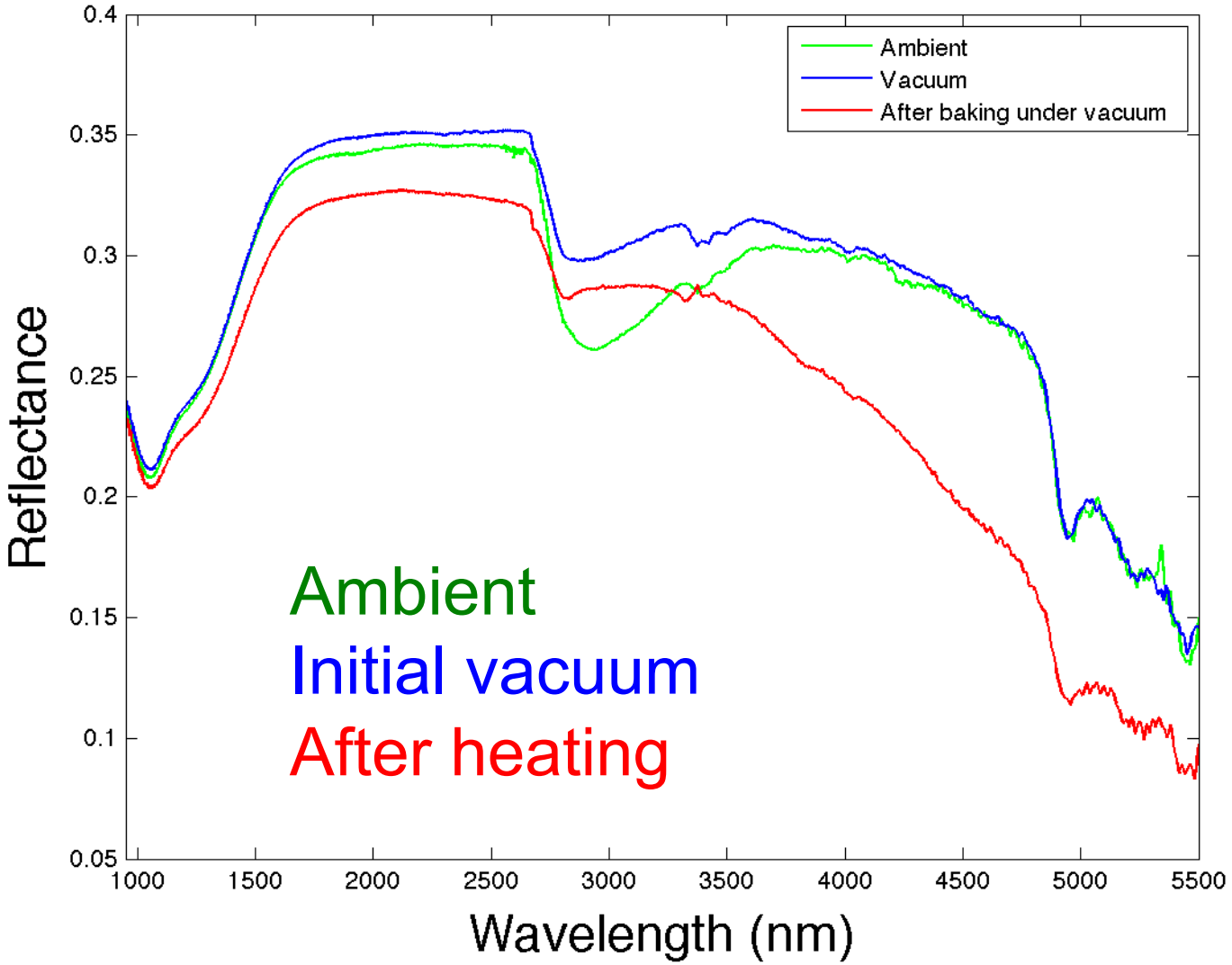
Desiccation affects the 3-micron region. Band depth and position change.



Combination of internal and adsorbed "water"

IR Water Band – San Carlos Olivine

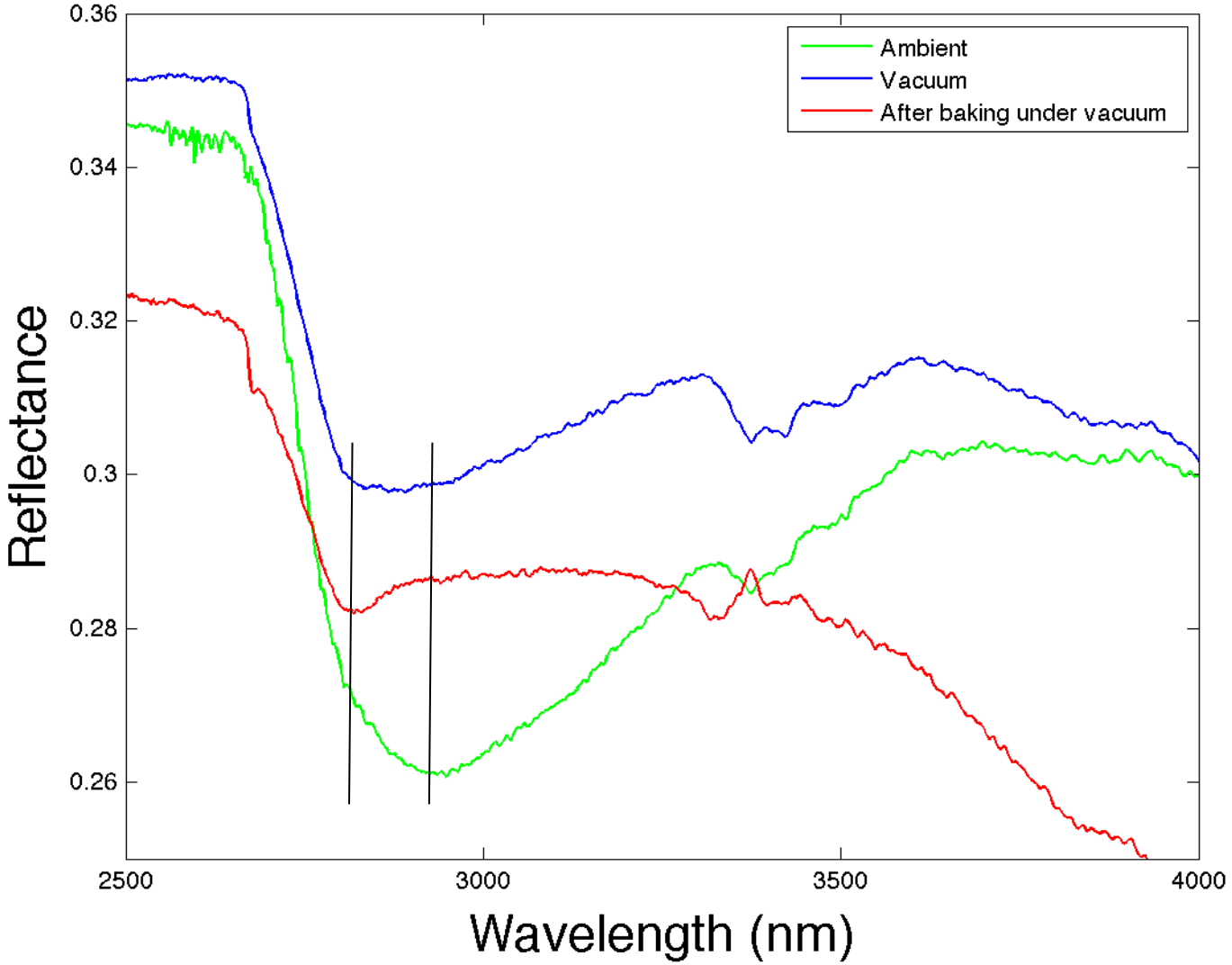
Desiccation affects the 3-micron region. Band depth and position change.



Combination of internal and adsorbed "water"

IR Water Band – San Carlos Olivine

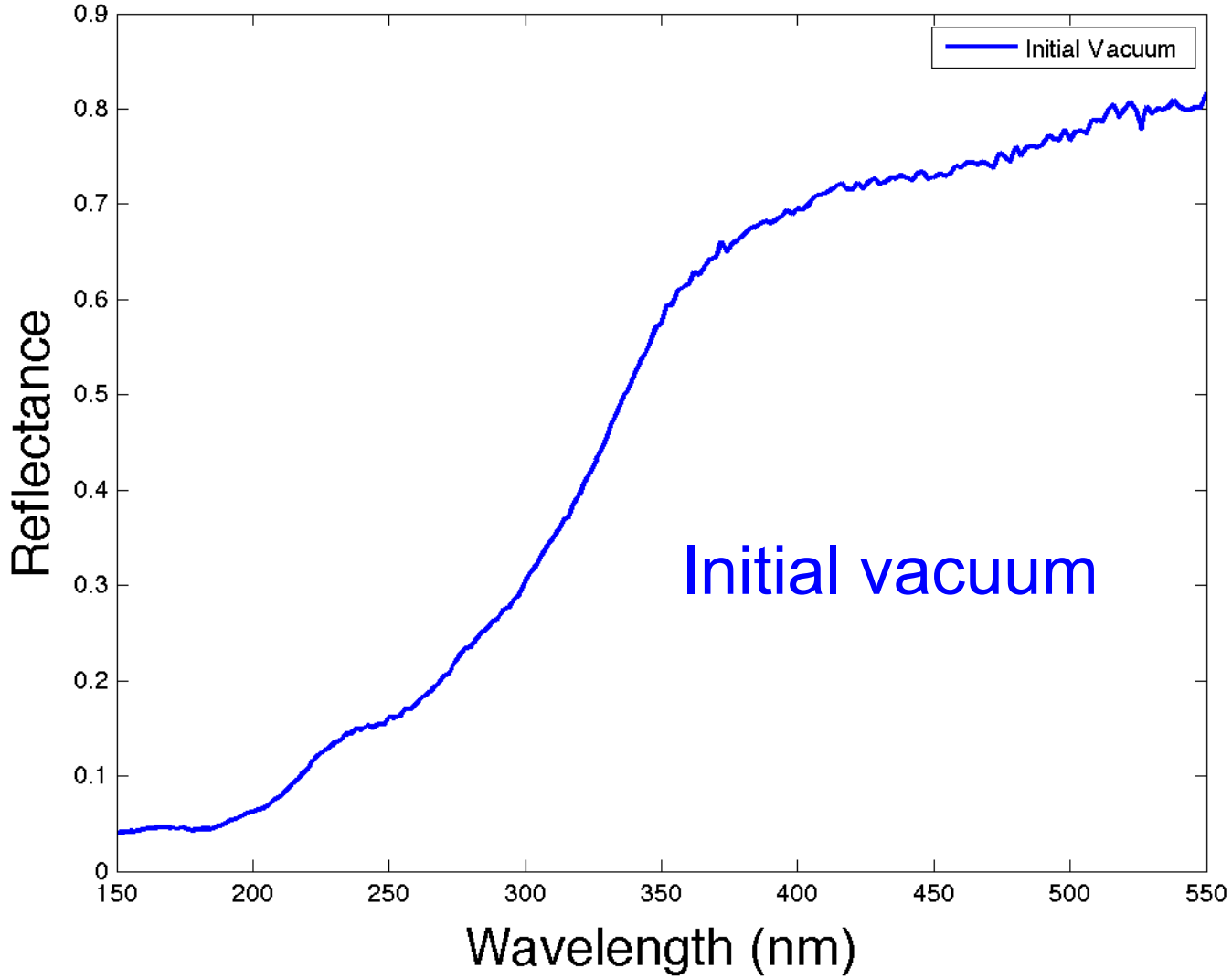
Desiccation affects the 3-micron region. Band depth and position change.



Combination of internal and adsorbed "water"

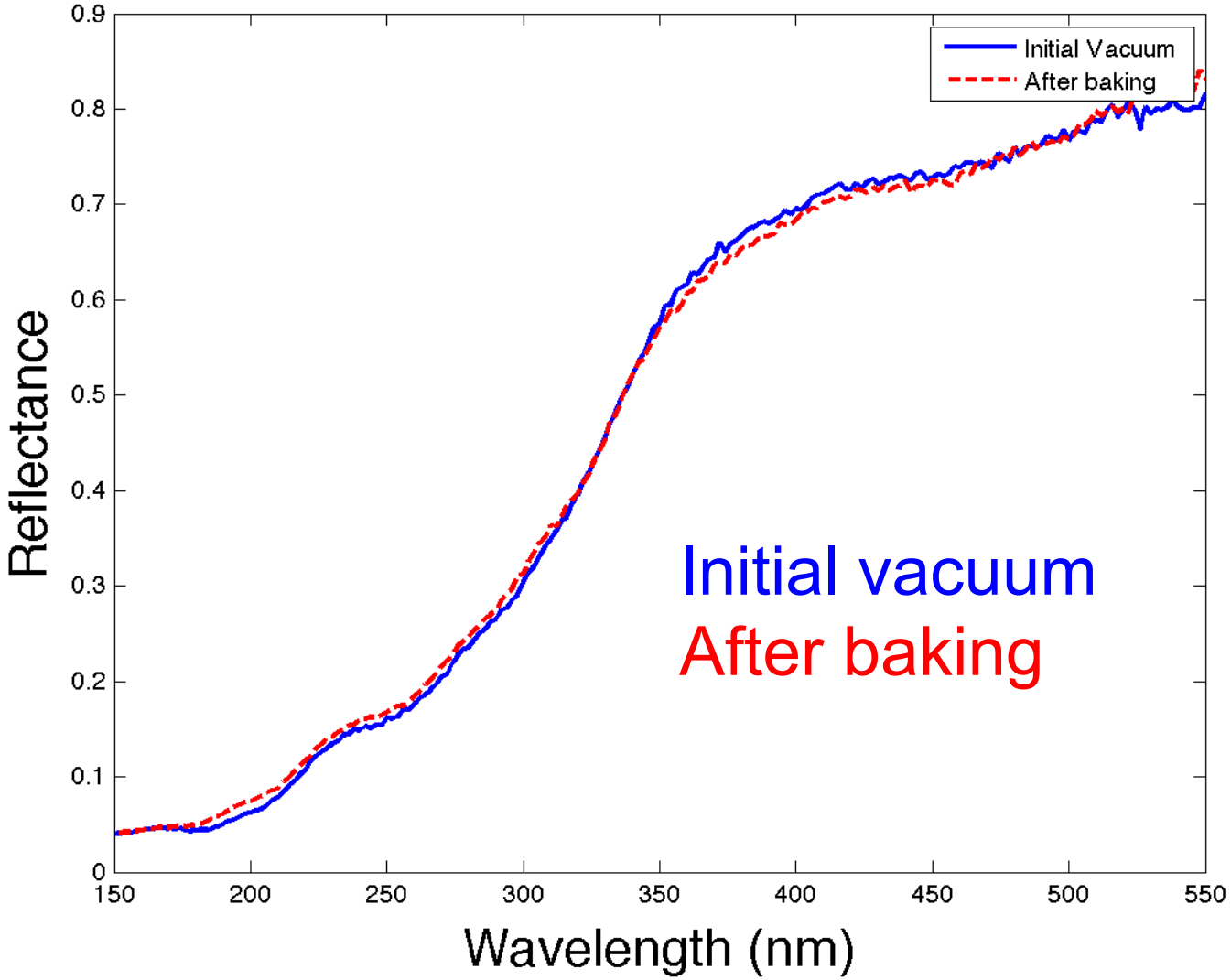
UV Absorption – San Carlos Olivine

Desiccation has no apparent affect in the UV.



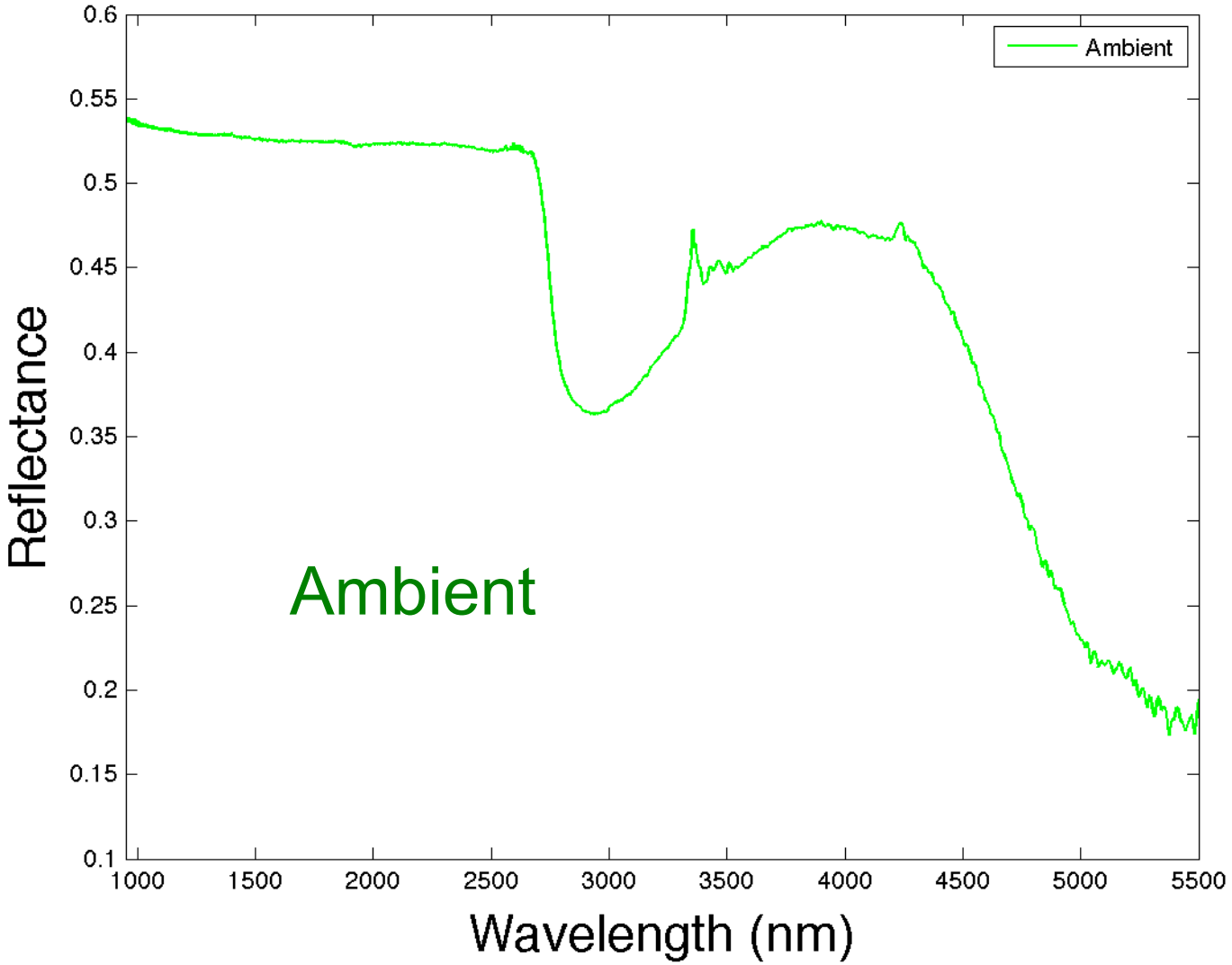
UV Absorption – San Carlos Olivine

Desiccation has no apparent affect in the UV.



IR Water Band – iron & water free silicate glass

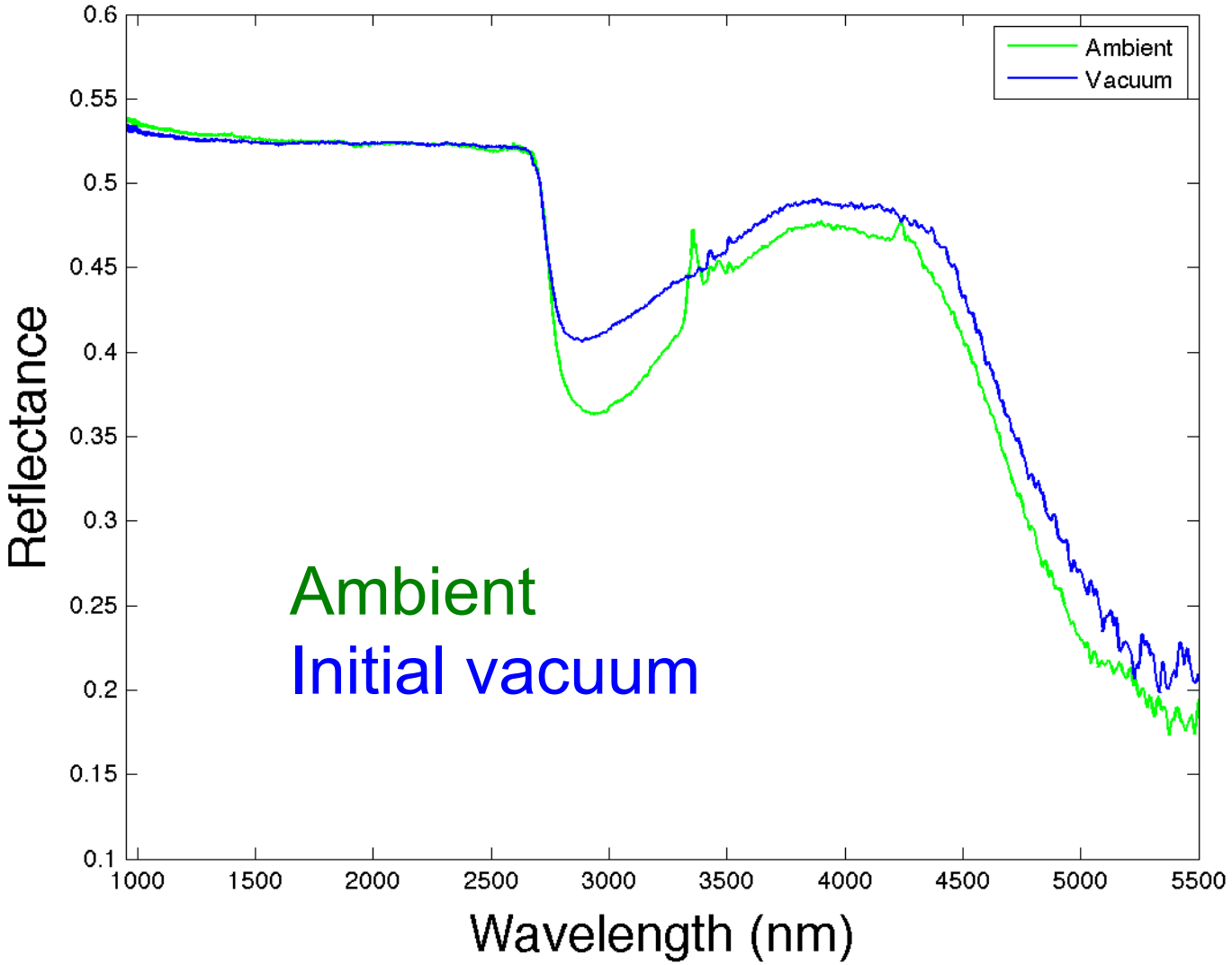
Desiccation affects the 3-micron region. Band depth and position change.



Adsorbed "water" only

IR Water Band – iron & water free silicate glass

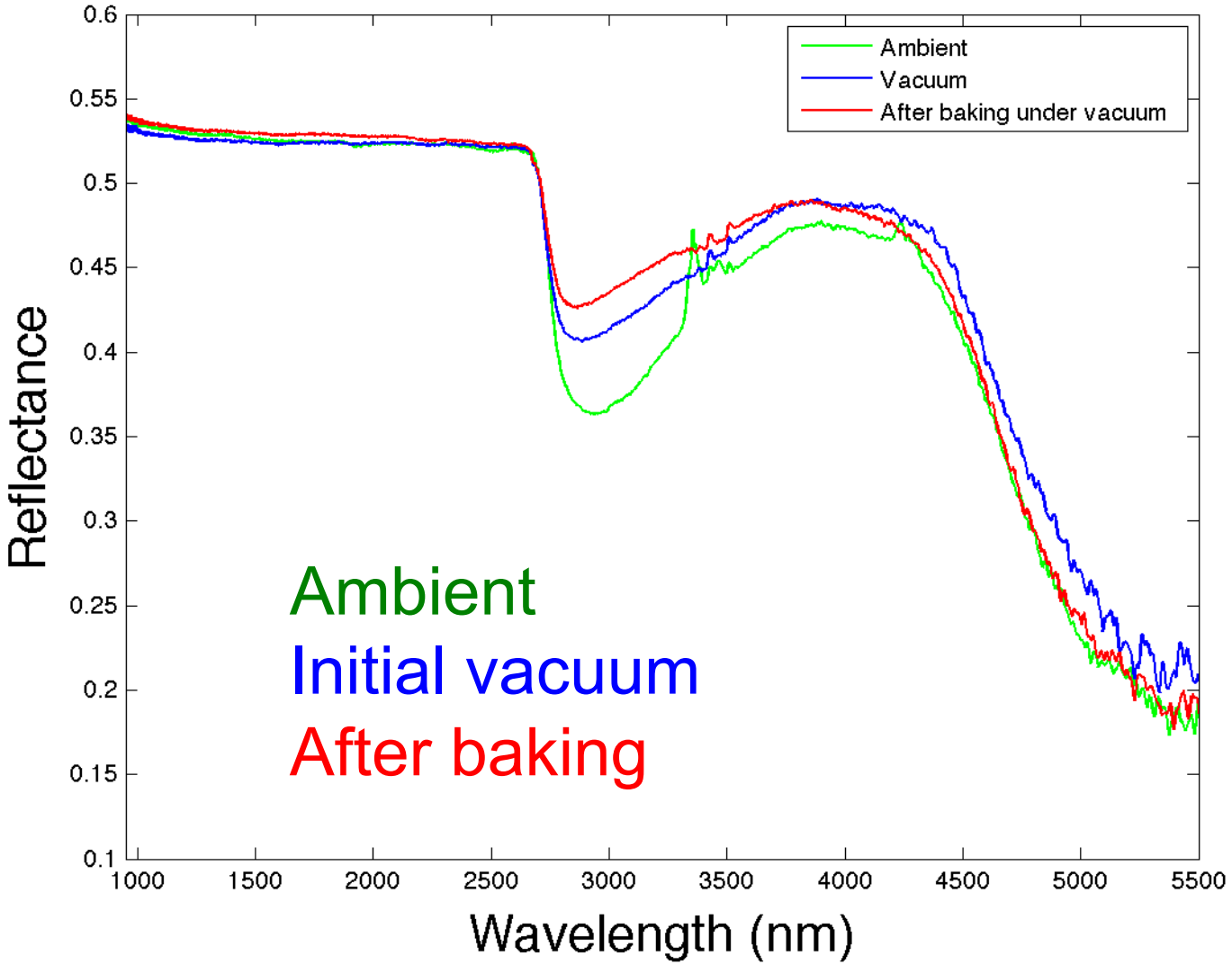
Desiccation affects the 3-micron region. Band depth and position change.



Adsorbed "water" only

IR Water Band – iron & water free silicate glass

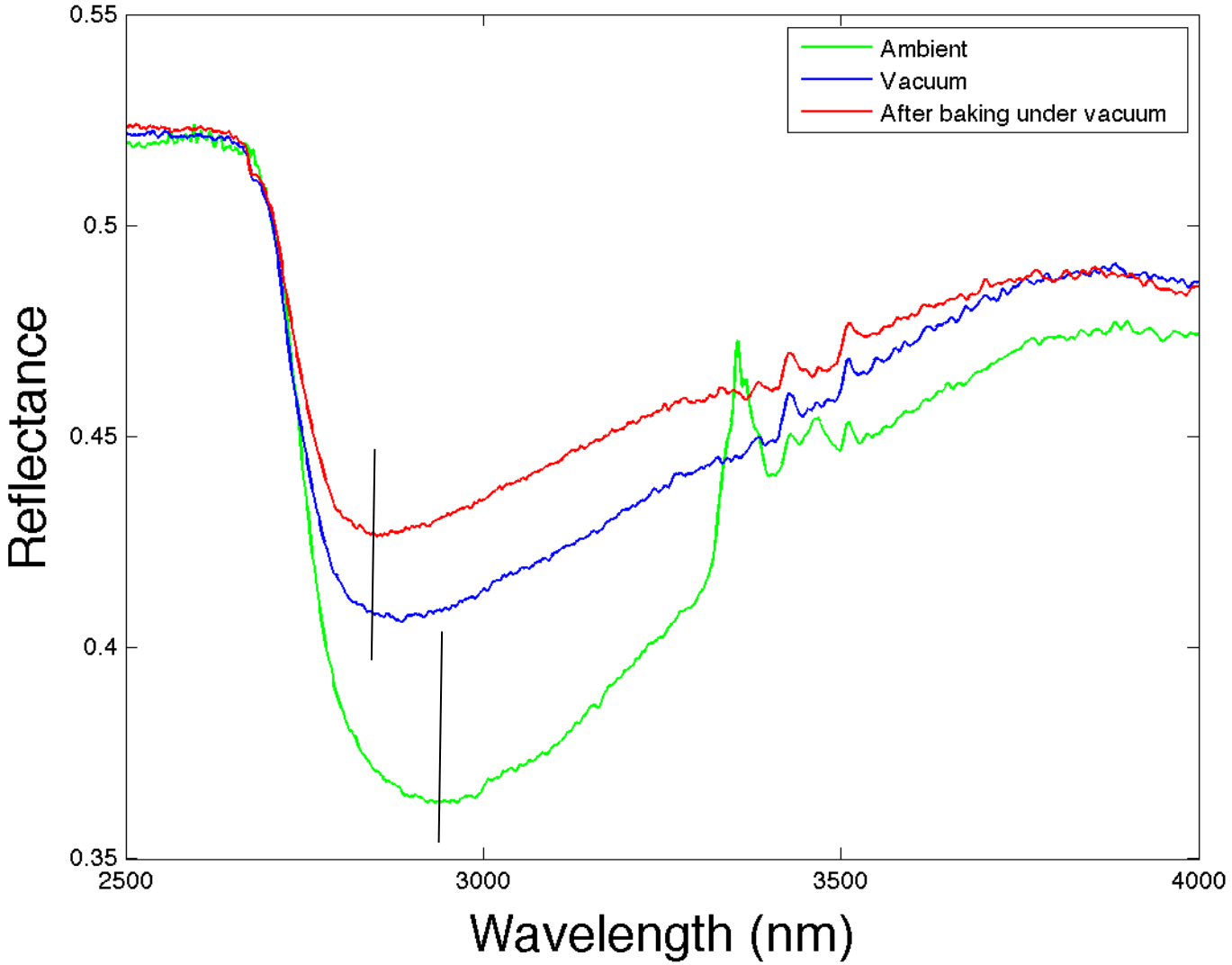
Desiccation affects the 3-micron region. Band depth and position change.



Adsorbed "water" only

IR Water Band – iron & water free silicate glass

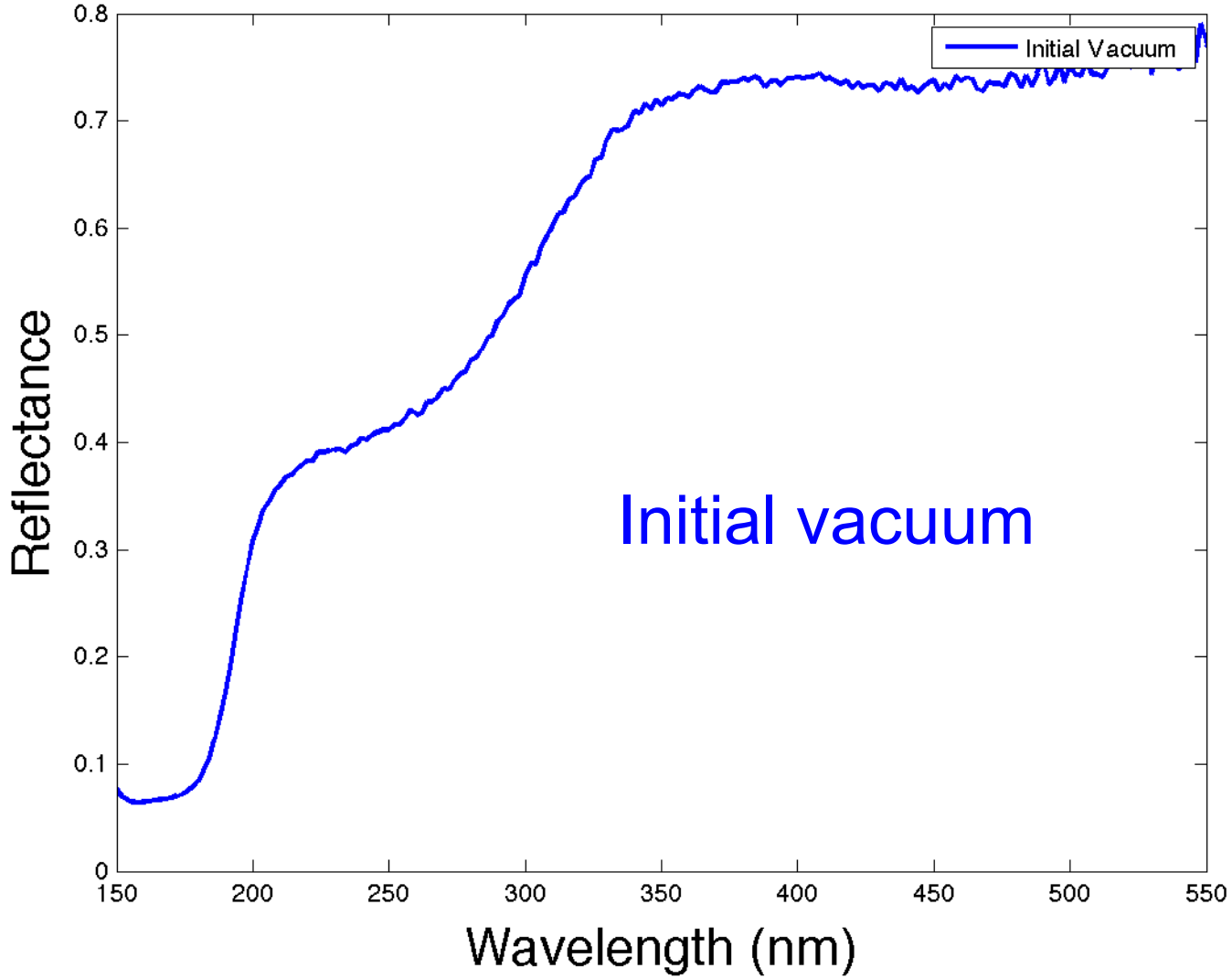
Desiccation affects the 3-micron region. Band depth and position change.



Adsorbed "water" only

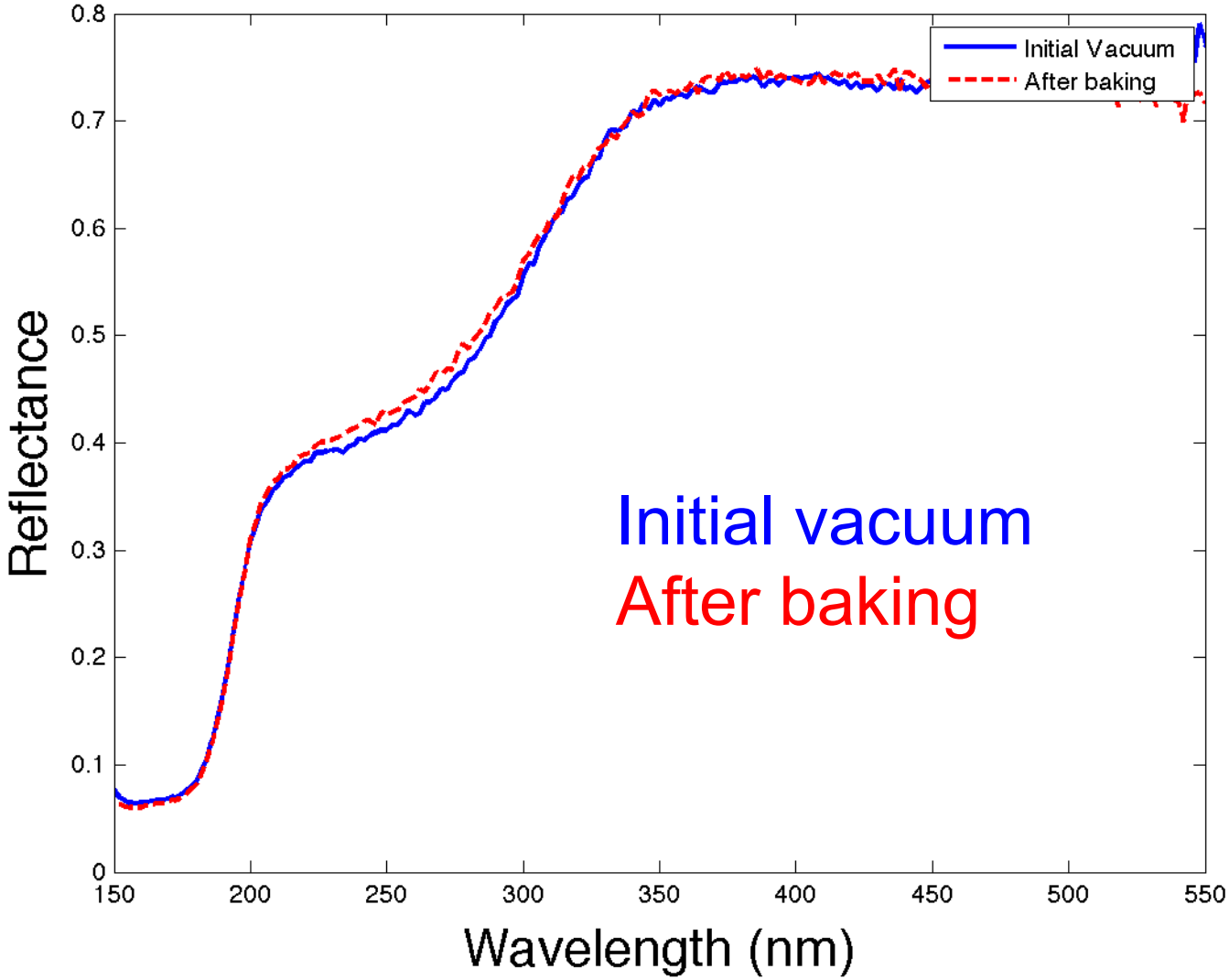
UV Absorption – iron & water free silicate glass

Desiccation has no apparent affect in the UV.



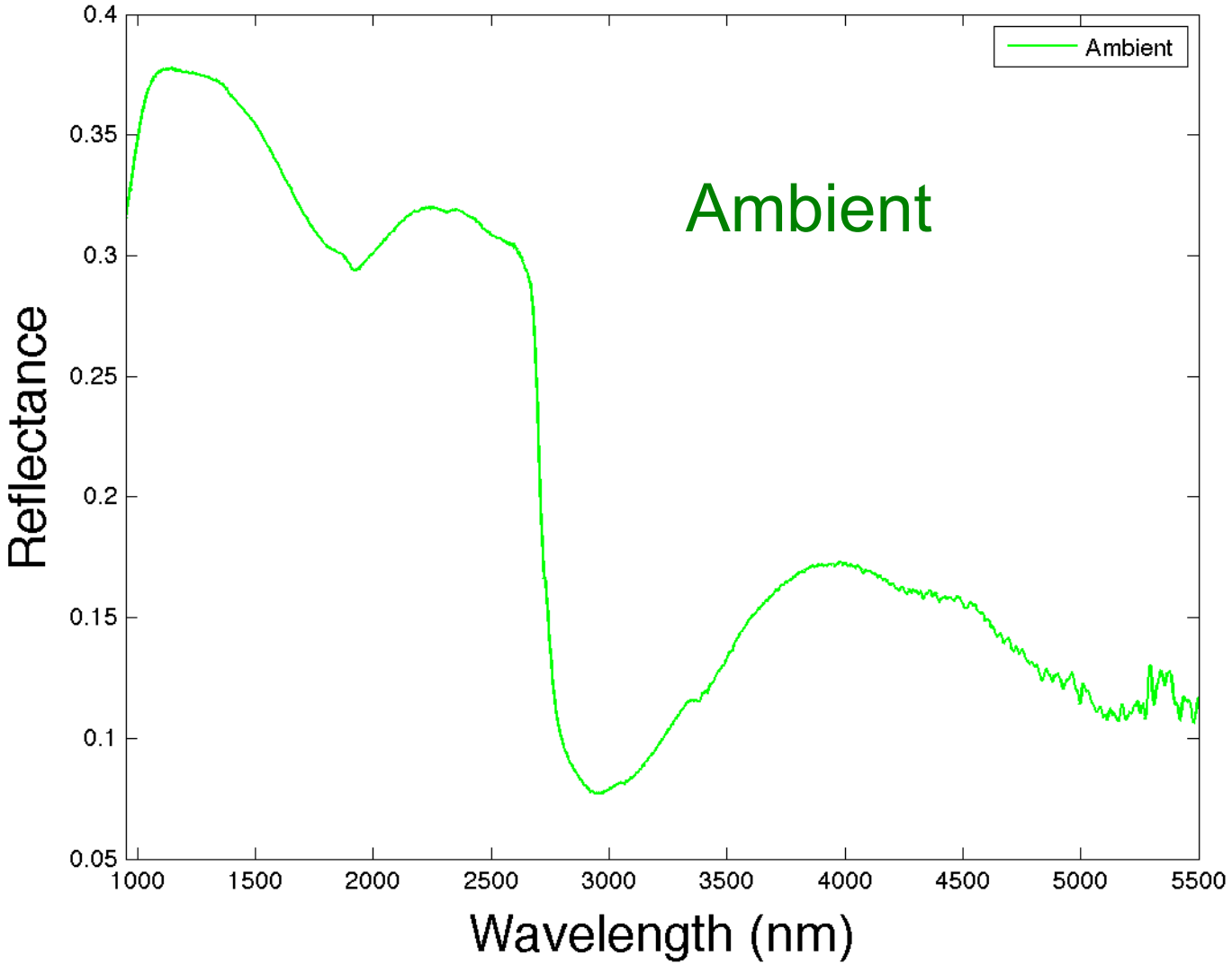
UV Absorption – iron & water free silicate glass

Desiccation has no apparent affect in the UV.



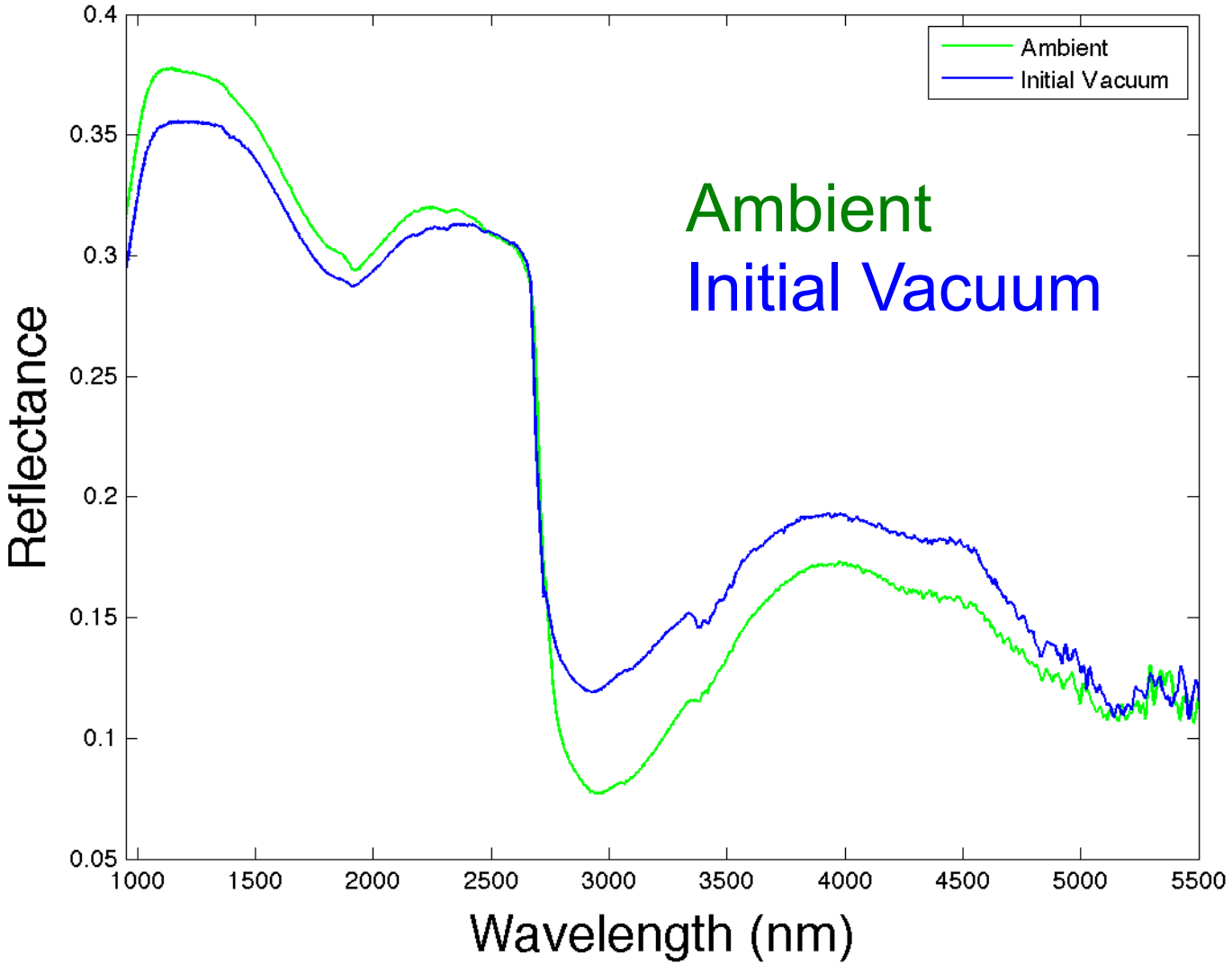
IR Water Band – Enstatite

Desiccation affects the 3-micron region. Band depth and position change.



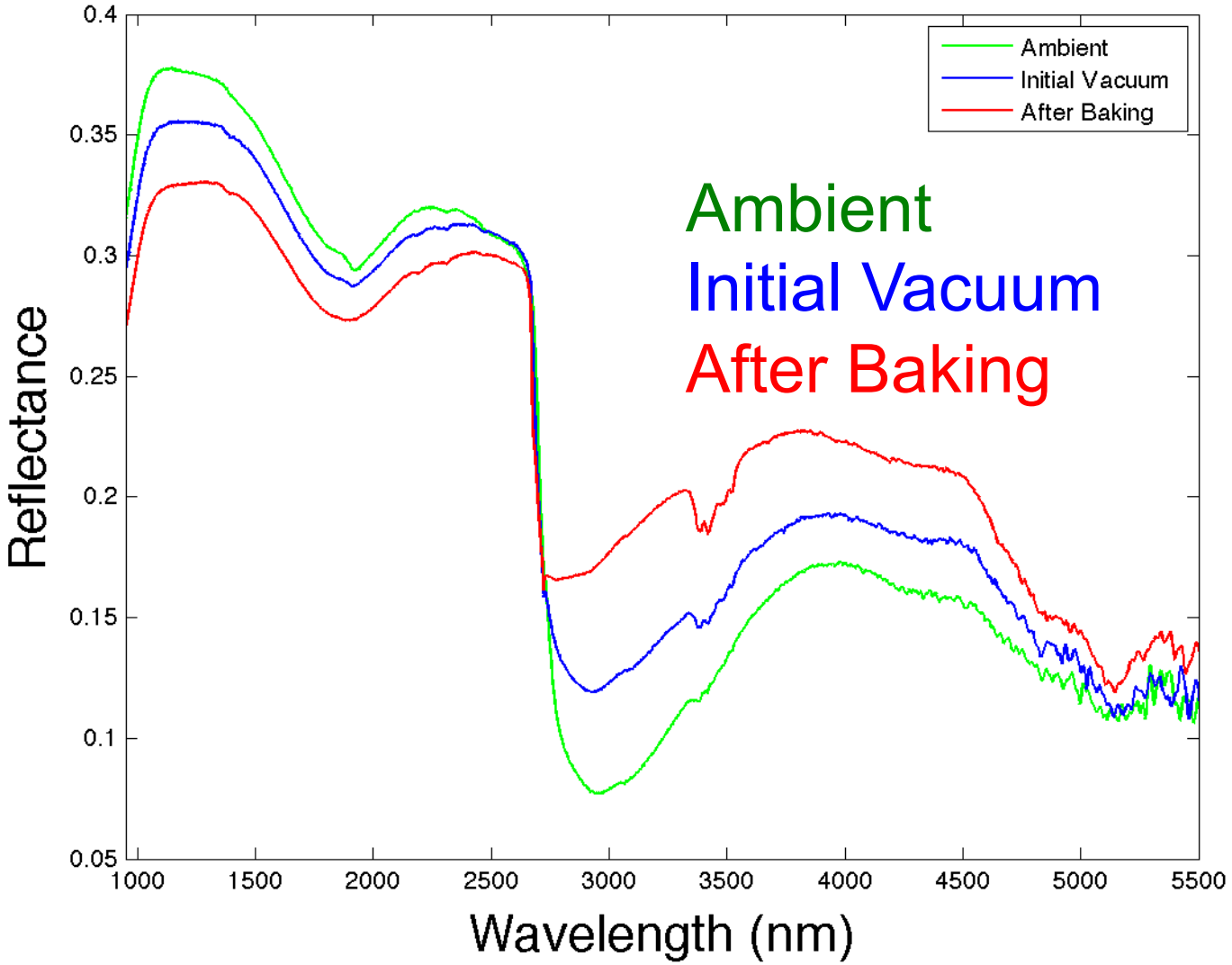
IR Water Band – Enstatite

Desiccation affects the 3-micron region. Band depth and position change.



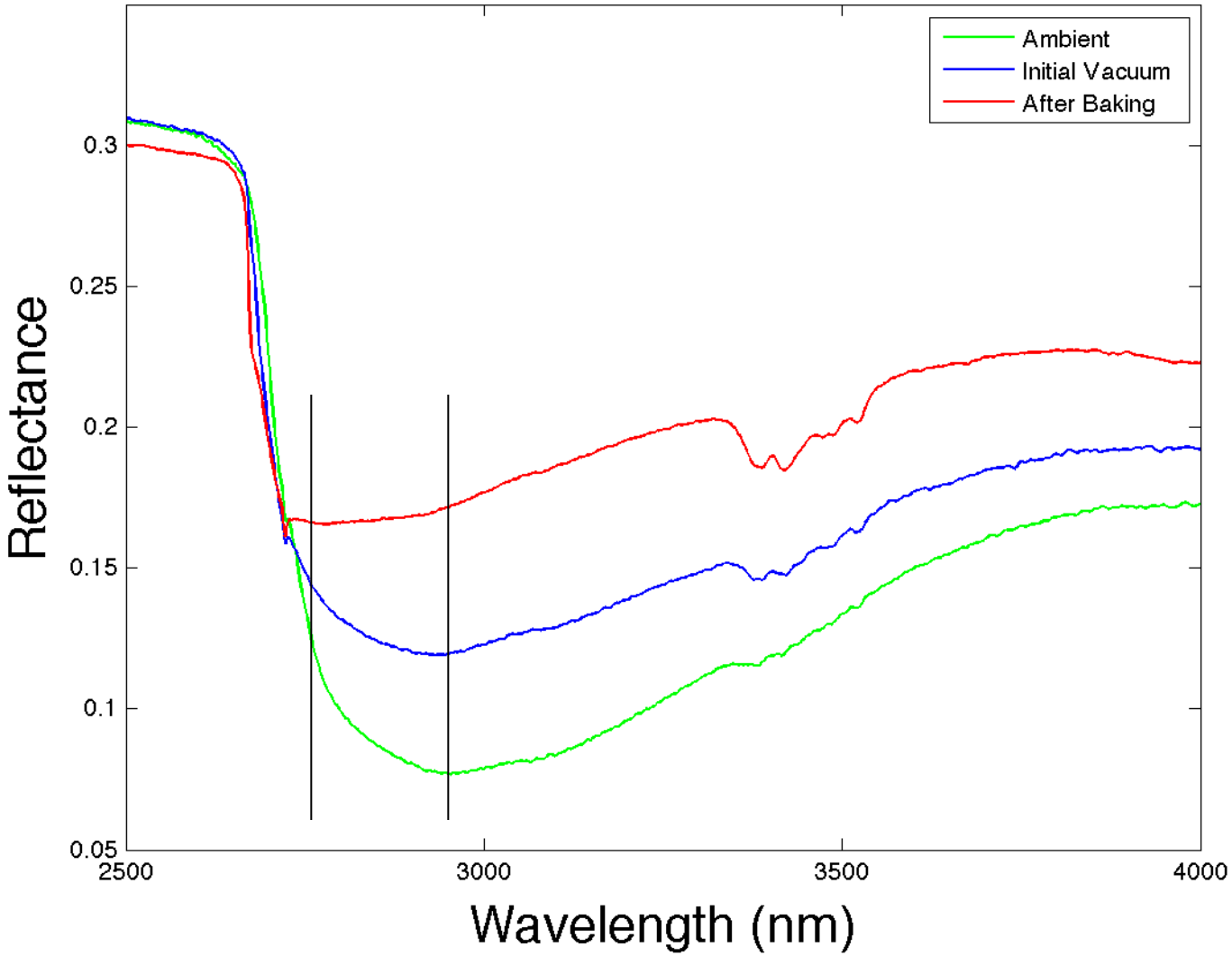
IR Water Band – Enstatite

Desiccation affects the 3-micron region. Band depth and position change.



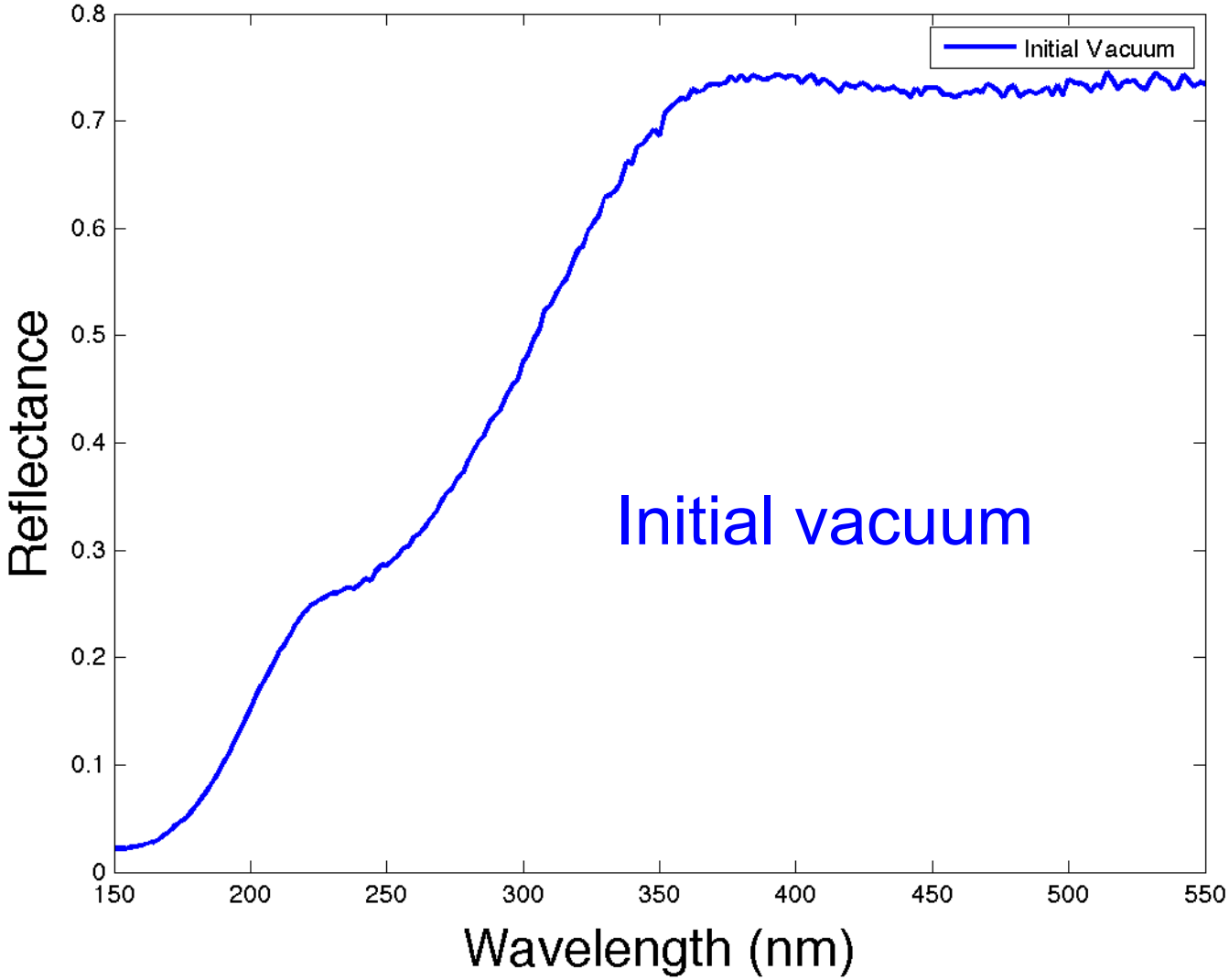
IR Water Band – Enstatite

Desiccation affects the 3-micron region. Band depth and position change.



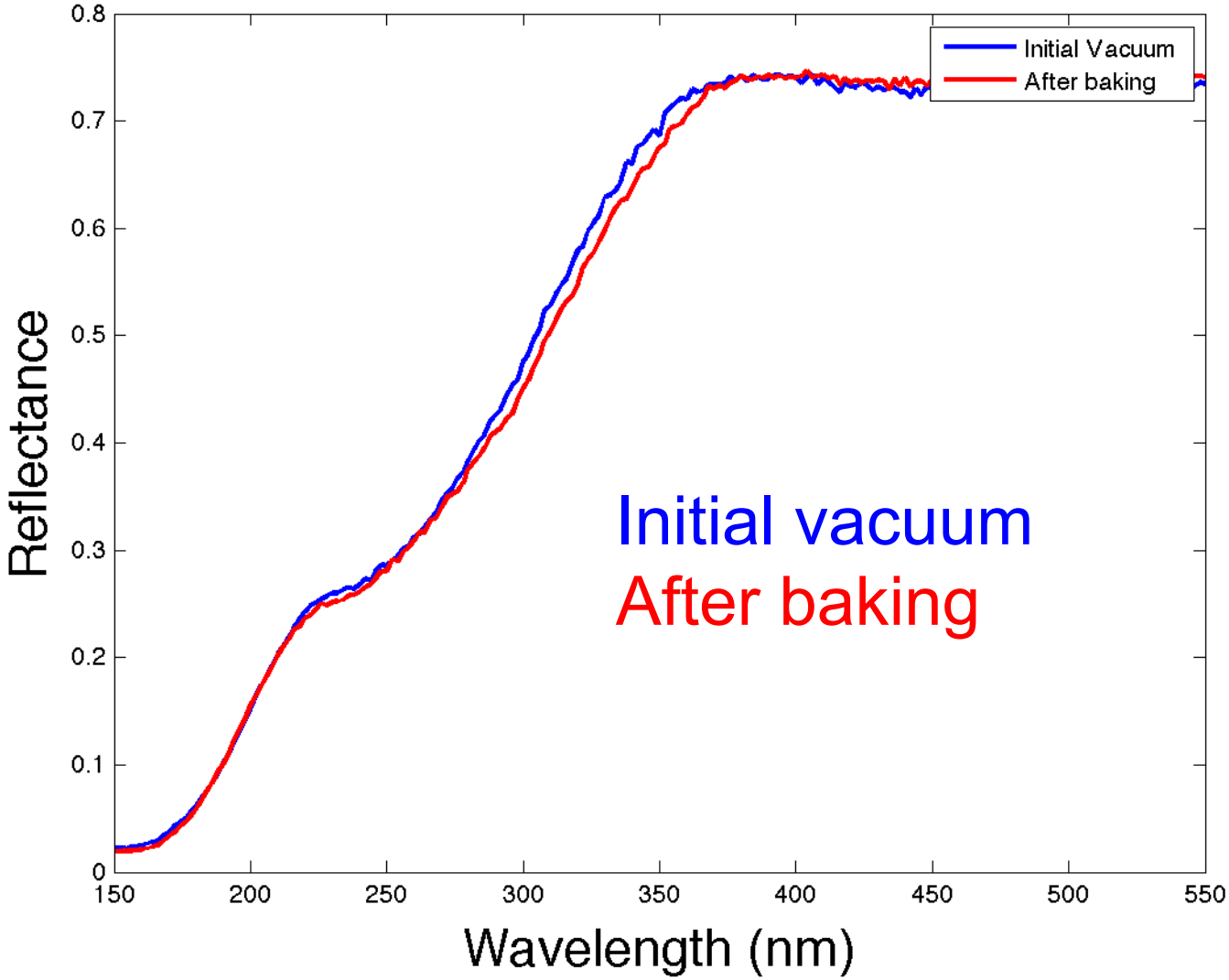
UV Absorption - Enstatite

Desiccation has no apparent affect in the UV.

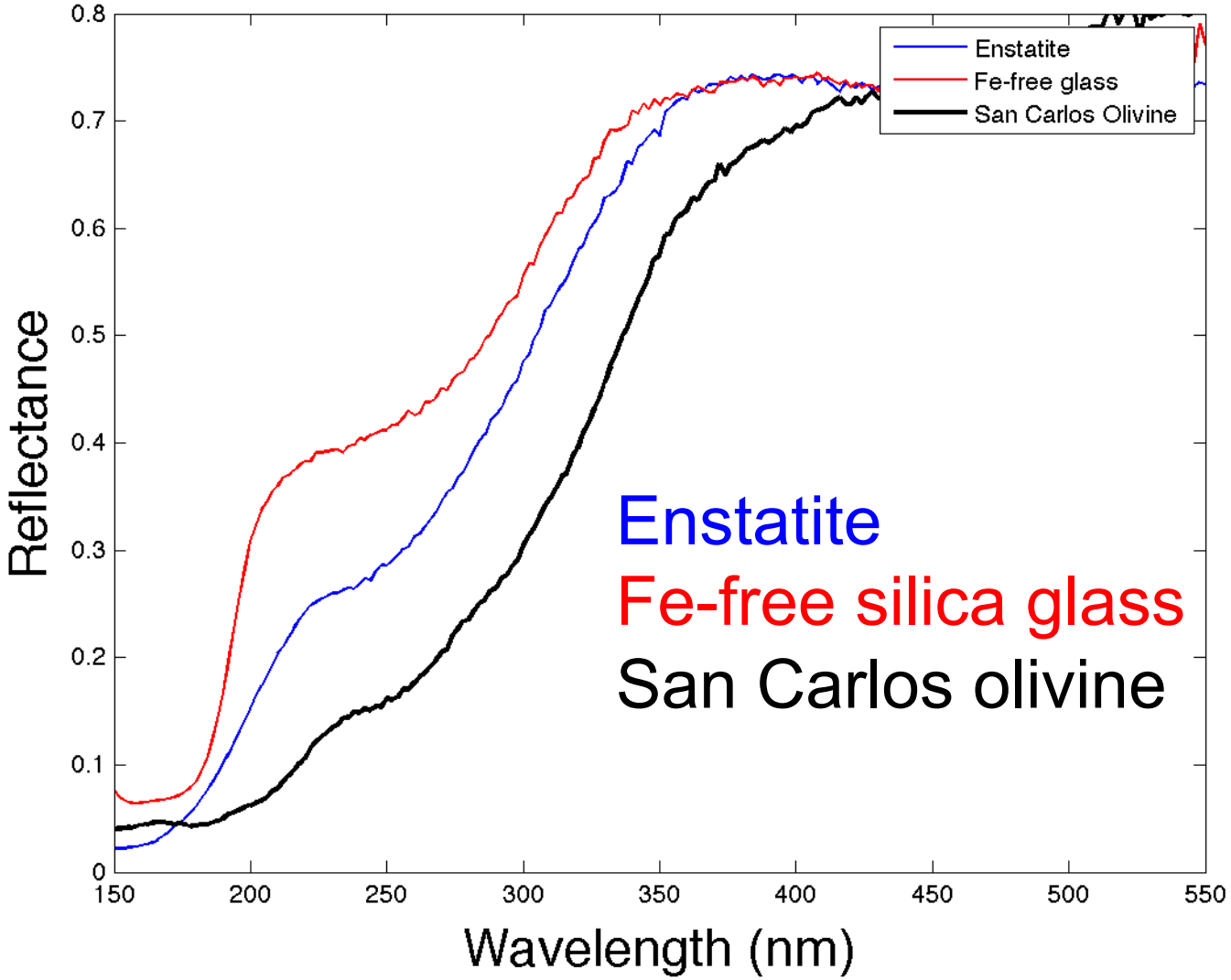


UV Absorption - Enstatite

Desiccation has no apparent affect in the UV.



UV Absorption – Compositional effects



Conclusions

As know, the IR is sensitive to small variations in water/hydroxyl abundance

Samples show consistent spectral changes with desiccation

The NUV-VUV is not sensitive to the presence of adsorbed water/hydroxyl on (some?) silicate minerals and glasses.

Implies the 2s to 2p orbital transitions responsible for the band in water ice, do not occur for OH.

The lack of sensitivity of the NUV-VUV to adsorbed water/OH may make it useful for characterizing silicate composition and uniquely identifying the presence of water ice.

The OMCT band from ~ 160nm to 350 nm is sensitive to variations in composition of silicate minerals including minerals with low or no iron abundance. Need to understand the effects various mechanisms of space weathering.